SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

FEBRUARY 1899.

GENERAL PHYSICS.

226. *Deformation of Metals affected by Time.* **G. Charpy.** (Paris, Soc. Franc. Phys. Bull. 114. pp. 1–2, 1898.)—The deformation produced by a force acting on a fragment of metal depends on the time during which this force acts. This phenomenon is more or less marked according to the nature of the metal; very marked with lead, it is almost inappreciable in the case of red copper under ordinary conditions of experiment. The author studies this latter case, which is particularly interesting since the crushing of copper cylinders is utilised for measuring the explosive pressures in closed spaces. Experiments effected by means of an apparatus allowing the time of crushing to vary from several minutes to 1/10 of a second prove that the deformation produced by a given charge is smaller as the duration of the time of action is shorter. It follows that the explosive pressures measured by these means with the tables actually employed are too small, and ought to be multiplied by a coefficient of value between 1·1 and 1·2. E. C. R.

227. *Surface Tension of Water.* **P. Volkmann.** (Wied. Annalen, 66. 2. pp. 194–206, 1898.)—Measurements of the surface tension of water in freshly drawn capillary tubes show a satisfactory agreement among themselves, which is independent of the substance and of the width of the tube. This agreement is not lost after two months, provided the tubes are kept under water, thus preserving the mobility of the liquid column. These results are opposed to those of Quincke, who found a considerable variation of the surface tension with width and substance of tube, even in freshly drawn tubes. The author attributes the

difference to a probable error due to Quincke's method of determining the width of the tubes. He finds that in old tubes cleaned with caustic potash and water the surface tension is less by 0·02 mg/mm. This he attributes to a higher solubility of newly drawn glass, thus indirectly conceding the influence of the substance of the tube. E. E. F.

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228. *Surface Tension of Mercury.* **J. Stöckle.** (Wied. Annalen, 66. 3. pp. 499–522, 1898.)—According to Quincke, the values of the surface tension of mercury found by different physicists vary between 44 and 56 mg/mm. The author seeks the cause of the discrepancy in the condensation of gases in the mercury surface. He eliminated it by observing the scale divisions of a glass scale as reflected in a drop of mercury in a vacuum. The drop projected from the end of a vertical tube introduced from below into a vacuum by means of an air-tight joint. He found that the surface tension of mercury in a vacuum only filled with residual mercury vapour is constant, and amounts to 44·4 mg/mm. In gases, the surface tension is greater when the surface is fresh, but the excess disappears after a while, rapidly in hydrogen, and slowly in nitrogen. It is due to a condensation of the gas on the surface, which is known to be most active in the case of hydrogen. E. E. F.

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229. *Surface Tension of Mercury.* **G. Meyer.** (Wied. Annalen, 66. 3. pp. 523–529, 1898.)—The condensation of a gas on the surface of mercury may be almost entirely eliminated in surface-tension measurements by measuring the waves on a jet of mercury. This may be described as the dynamic method. The values obtained are always larger than those obtained by the static method, evidently because the decrease of surface tension brought about by condensation has no time to set in. The values obtained are, for air 51·5, oxygen 51·4, nitrogen 50·5, carbonic acid 49·6, and hydrogen 56·5. E. E. F.

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230. *Physical Properties of Caoutchouc.* **A. E. Lundal.** (Wied. Annalen, 66. 4. pp. 741–759, 1898.)—Among the peculiarities studied are the absorption of paraffin oil and its attendant changes of density, the expansion, elasticity, and compressibility of caoutchouc, and certain thermodynamic phenomena connected with it, such as the loss of heat on sudden stretching. E. E. F.

231. *Newton's Third Law of Motion.* **P. Volkmann.** (Wied. Annalen, 66. 4. pp. 781–784, 1898.)—The author points out, in correction of the prevailing assumption, that Newton's laws of motion do not deal with or lead up to the idea of central forces. The conception of the latter is based upon his law of gravitation, which in his system was one of the final conclusions arrived at.

E. E. F.

232. *Gravitational Constant.* **F. Richarz** and **O. Krigar-Menzel.** (Wied. Annalen, 66. 2. pp. 177–193, 1898.)—The constant of gravitational attraction was determined by means of a double balance, provided, in addition to the ordinary scales, with another pair of scales attached to the upper pair by means of rods 226 cm. long. Two kilogramme weights were placed on the upper right- and the lower left-hand scale respectively, and the difference of weight due to the difference of altitude was determined. Then a mass of lead 100,000 kgr. in weight was introduced between the upper and lower scales, and the weight of a kilogramme above and below the mass was determined. The result gave the attraction of the mass, free from errors due to difference of altitude. The value for the gravitational constant obtained was $(6{\cdot}685 \pm 0{\cdot}011) \times 10^{-8}$ cm.^{3}/gr. sec.^{2}, and the value for the earth's mean density was $5{\cdot}505 \pm 0{\cdot}009$. E. E. F.

233. *Stellar Velocities.* **W. W. Campbell.** (Ast. Phys. Journ. 8. pp. 123–159, 1898.)—As illustrative of a paper on the new "Mills Spectrograph" recently acquired by the Lick Observatory, the author gives tables showing the results of his observations on the velocity of stars in the line of sight. In all he discusses twelve stars, and a valuable addition is the comparison he gives with previous observations by Vogel and Scheiner.

Another very valuable adjunct is the bringing together of the formulæ and data required for computing the velocity of a planet at any instant with respect to the earth or the sun. These are requisite before any estimate can be made of a star's velocity, and reference to the table in the paper will facilitate their determination. Attention is drawn (p. 157) to the exceedingly large velocities of the three stars η Cephei, ζ Herculis, and G. C. 4373, all having a velocity greater than 50 kilometres per second.

C. P. B.

234. *Nickel and its Alloys.* **C. E. Guillaume.** (Écl. Électr. 16. pp. 287–292, 1898.)—This contains a summary of the results obtained by the author in his researches on nickel and nickel-steels, of which he has published an account in a small pamphlet. The principal points are referred to in Abstract

No. 1115 (1898.) The author considers that some of the peculiarities noticed may be due to a variation of the affinity of iron and nickel according to temperature. Various practical uses for the alloys are suggested, such as in instruments where a small coefficient of expansion is desired in the material, or where this expansion should be the same as that of glass. Another use might be the complete compensation of pendulums for temperature, and not merely for two temperatures. J. J. S.

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235. *Macrae Curve-Tracer and Integrator.* (West. Electn. 23. p. 52, 1898.)—In this instrument a number of pencils are arranged to act on a continuous band of section paper so as to mark at suitable distances apart. These pencils are each mounted on a sliding rack-bar, adapted to be moved by a pinion on a shaft provided with a handle and with a pointer moving over a graduated scale; a ratchet-feed is also provided for moving the continuous band forward through a predetermined distance by actuating a lever. Each dial is graduated according to the quantity to be indicated in the corresponding curve, for example, volts, amperes, steam-pressure in lbs. per sq. in. When a set of readings is to be taken and recorded, the pointers are set to the observed values and the paper-band then moved forward through unit distance so as to mark part of a stepped curve.

To measure ampere-hours, or other quantities involving integration, the dial is provided with two pointers, one of which is fixed on the shaft and marks the position of the pencil which traces the curve. The other pointer is connected to the fixed pointer by a clutch in such a manner that when the fixed pointer is moved forward it brings the auxiliary pointer along with it, but when the fixed pointer is moved back, the auxiliary pointer remains stationary. Each time the fixed pointer is to be set for a reading, it is first moved back to zero and then brought to the position in which it is to remain until the next reading is taken. The auxiliary pointer thus integrates the curve recorded. C. K. F.

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236. *Relief-Pictures for the Blind.* — **Dussaud.** (Comptes Rendus, 127. pp. 417–418, 1898.)—This is a hypothetical arrangement of perforated screens and selenium cells for producing relief-models of a luminous picture. Each cell actuates a telephone, the diaphragm of which communicates motion to a rod, thrusting it forward or causing it to recede. The ends of all the rods map out a surface which at any instant depends upon the illumination of the distributed cells. It is proposed by this means to convey to the blind some idea of the form of the luminous picture. R. A.

LIGHT.

237. *Illustrations of Optical Phenomena.* **J. D. Everett.** (Phil. Mag. 46. pp. 227–243, 1898.)—Analogies drawn from chains of particles and from mutually influencing pendulums are used to illustrate certain optical phenomena. The methods of establishing the most important properties are selected so as to be brief and simple, and the author has arranged both proofs and results in a form convenient for reference. The properties of the double pendulum are discussed very fully. The usual investigation with regard to mutually influencing pendulums is simplified by first assuming the motion to take place in a fundamental mode, and afterwards discussing combinations of such modes. The discussion of the simple harmonic vibrations of a chain of particles is applied to explain Stokes's illustration of fluorescence. Lord Rayleigh's application of the case of the pendulums to explain anomalous dispersion is referred to; and also Sellmeier's theory of fluorescence. J. J. S.

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238. *Newton's Rings.* **T. C. Porter.** (Phil. Mag. 46. pp. 245–252, 1898.)—A description is given of a new method of viewing Newton's rings by the light emitted from the two interior surfaces of two glass plates placed close together, free from all other light except only that due to reflections in the air-space. The subordinate interference systems which coexist with the primary rings are for the first time shown to the eye, and these can be analysed experimentally. The results obtained indicate that most probably the interference of monochromatic light in forming the rings is never absolutely complete, though very nearly so. J. J. S.

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239. *Colour-Vision.* **F. P. Whitman.** (Science, 8. pp. 305–316, 1898.)—An interesting historical summary of the various theories which have been put forward to account for colour-vision. J. J. S.

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240. *Colour Measurement.* **T. E. Doubt.** (Phil. Mag. 46. pp. 216–222, 1898.)—After discussing the standards used by Maxwell, Rayleigh, and Helmholtz, the author proceeds to describe an instrument designed to compare the mixture of two or more components of a single light source with the original light source itself. The instrument consists of a spectroscope used after Foucault's plan for colour mixtures, but employing a concave silver-on-glass mirror instead of a lens to collect the

isolated components of the analysed light. By sending the beam through the prism system twice, the instrument is made very compact, and the method of comparison by using a diagonal silvered mirror between the slit and collimating lens allows of the original light being seen in juxtaposition with the colour or mixture of colours with which it has to be compared. The paper gives the colour equations for white light obtained by using three different sources of comparison—an Argand burner, an amyl acetate lamp, and a Carcel lamp. C. P. B.

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241. *Measurement of Illumination.* **Onimus.** (Comptes Rendus, 127. pp. 663–664, 1898.)—This apparatus for measuring the total intensity of daylight consists of a box in the lid of which are 24 holes hearing the numbers 1 to 24. Hole No. 1 is covered by a film of collodion slightly tinted with Aurentia, hole No. 2 with two films superposed, and so on. Sensitive paper (preferably ferro-prussiate) is exposed under the holes, and the highest number marked on the paper is a relative measurement of the intensity. E. C. R.

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242. *Theory of Welsbach Incandescent Mantle.* **Bunte.** (Paris Soc. Franc. Phys. Bull. 114. p. 2, 1898.)—Nearly all mantles in use have practically the same composition—88 to 89 per cent. oxide of thorium, 20 per cent. oxide of cerium, and traces of other matter which only play a quite secondary part. The lighting power of mantles is not due to any special emissive power, as is proved by observing the emissivity of oxides of thorium, cerium, and magnesium, and of retort carbon heated in an electric furnace to a temperature of about 2,000°. The lighting power results simply from the high temperature to which the mantle is raised, and which is due (1) to the catalytic properties of oxide of cerium and (2) to the fine sub-division of the latter. The presence of oxide of cerium lowers the temperature of combustion of a mixture of oxygen and hydrogen from 650° to 350°; the combustion is consequently strongly active in the neighbourhood of the mantle, and a large quantity of heat is disengaged. The oxide of thorium forms a porous mass consisting of a large number of very fine filaments, which are coated with oxide of cerium. On account of the bad conductivity of these fine filaments, the heat, instead of being rapidly dissipated in the mass, is concentrated on the filaments, and the mantle is raised to a very high temperature. It is certain that the two oxides are both necessary to obtain a good result, for mantles of pure oxides of thorium or cerium give ten to twenty times less light. E. C. R.

243. *Prismatic Images.* **R. Straubel.** (Wied. Annalen, 66. 2. pp. 346–349, 1898.)—The author shows that when a plane surface is viewed through a prism, the orientation of the image is different from that of the object, and that this orientation is independent of the distance of the object. In Abbé's dilatometer, for instance, a focal difference of 3·76 cm. corresponds to an extension of the object normally to the refracting edge by 1 cm.

E. E. F.

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244. *Distribution of Light on the Focal Plane of a Photographic Objective.* **M. von Rohr.** (Zeitschr. Instrumentenk. 18. pp. 171–180 and 197–205, 1898.)—The light falling upon any particular part of the photographic plate is modified (1) by the behaviour of oblique rays in the lens, and (2) by the partial obscuration of the diaphragm aperture by the lens-mount, for points beyond a certain distance from the axis. Taking the former of these first, we find that oblique pencils coming through the diaphragm at an angle u with the primary optical axis are given not a circular section with diameter $2a$, but an elliptical section with axes $2a$ and $2a \cos u$, and area $\pi a^2 \cos u$. The flux of light towards the diaphragm-aperture, I_u at an angle u, is therefore equal to $I_o \cos u$, where I_o is the axial flux of light towards the diaphragm. Then as to the illumination on the plate (assuming the lens well corrected), if the beam leaves the lens under an obliquity u^1, the flux of light in the direction of the oblique rays varies as $\cos u$ by reason of the smaller flux through the obliquely illuminated diaphragm aperture, and also as $\cos^2 u^1$ by reason of the greater distance between the diaphragm and the part of the plate illuminated. So that the flux obliquely at angle u^1 is $J^1_u \sim J^1_o \cos u \cos^2 u^1$ where J^1_o is the axial flux in the direction of the rays. To make this an equation we need a multiplier: but this multiplier will not, on account of the varying effects of absorption and reflection, be the same for all angles of incidence: call it K_u. Further, when d is the diaphragm aperture and f the focal length of the lens, the axial flux J^1_o is d^2/f^2. Lastly the flux incident upon the plate, per unit of area, is $J^1_u \cos u^1 = I^1_u$. Whence

$$I^1_u = \frac{d^2}{f^2} . K_u . \cos u . \cos^3 u^1 .$$

Discussion of the varying values of K_u, taking polarisation into account, leads to the conclusion that K_u is a product of two calculable factors, one relating to absorption and the other to reflection, and that the latter is approximately constant for all angles of incidence within a working angle of about 70° for Zeiss single and double anastigmats series vi., and about 23½° for Petzval portrait combinations. The latter result is obtained with very varying combinations of lenses within fairly wide working angles, so that reflection does not make any material difference in the illumination produced by direct and oblique rays respectively. As to absorption there is a want of data as to absorption coefficients. (See Krüss, Centralz. f. Optik u. Mech. 11, 1890; Vogel, Sitz.-Ber. d. Berl. Akad. 2, No. 46, 1219–1231, 1896; Wilsing, Astronom. Nachr. 142, No. 3400, pp. 241–252, 1897). Generally, since marginal rays have a longer path in the more absorptive thick-edged flint glass and a shorter path in the less absorptive thin-edged crown, they are more powerfully absorbed than the axial rays: and the larger the scale on which the lens is made, if otherwise similar in form, the greater will be the absorptive effect, the logarithm of the absorption-factor being proportional to the linear dimension of the lens.

But the term $\cos u \,.\, \cos^3 u^1$ itself varies according to the type of the lens: for u being half the working angle of the lens (angles of landscape subtended at the anterior nodal-point, or angle of plate subtended at the posterior nodal-point—see Grubb, Brit. Journ. of Photogr. Nos. 166–171, 1869), u^1 varies with u according to the lens used. If $u > u^1$, $\cos u < \cos u^1$, and the fall in the value of $\cos u \,.\, \cos^3 u^1$ is relatively small. But simple lenses give barrel-shaped images, for u^1 is itself too small: and this, on the other hand, gives a less rapid fall-off in illumination than a realisation of the proper angle would do. If we take the axial illumination as unity, the corresponding values of $\cos u$ $\cos^3 u^1$ for the ideal lens, in which $\tan u^1$ bears a constant ratio to $\tan u^1$, are as follows: $u=5°$, 0·9877; 10°, 0·9512; 15°, 0·8927; 20°, 0·8150; 25°, 0·7222; 30°, 0·6193; 34°, 0·5333; whereas with a simple lens the ratios are 0·9877, 0·9515, 0·8942, 0·8193, 0·7317, 0·6368, and 0·5591. With a symmetrical combination the illumination at 34° is 0·4724 times the axial illumination.

If $u=u^1$, the expression becomes $\cos^4 u$. It is possible with symmetrical objectives; and the fall-off in illumination is more rapid than in the preceding case. If $u < u^1$ (asymmetric double objectives, and Petzval) the fall-off is still more rapid. Telephoto lenses come under this category. In general, the greater the distance between the focal plane and the point of apparent emergence the more even is the illumination, since the more nearly does the incidence approximate to the vertical.

The second cause of fall-off in illumination is partial obscuration of the diaphragm-aperture by the mount. With a plain meniscus lens the mount must be larger than the diaphragm, for the marginal rays crossing the axis are turned away from the axis while within the lens. If R be the maximum radius of diaphragm-aperture which allow rays to get past the mount, and r the actual diaphragm-radius employed at any moment, the angle within which there is no obscuration of the diaphragm-aperture is $w=\tan^{-1} (R-r)/d$, where d is the axial distance between the diaphragm and the obstructing edge of the mount: there is about a half obscuration at the angle $W=\tan^{-1} R/d$: and complete obscuration at the angle $\omega = \tan^{-1}(R+r)/d$. Between the last two angles there are no secondary axial rays passing through. The smaller the diaphragm-aperture the more abrupt is the transition between illumination and darkness. In holosymmetrical systems of two lenses the aperture required is always twice what would serve either of the lenses taken alone. With single and double Zeiss anastigmats of the same size, series vi., the following are the respective angles of view free from obscuration.

Diaphragm-apertures; single combinations f/	16·5	18·8	22	26	32
,, ,, double combination f/	8·5	9·7	12	14·7	19·8
Angles of unobscured field	5°	10°	15°	20°	25°

A holosymmetrical combination lets no rays through beyond those corresponding to angle W in a simple lens, and the fall-off at the margins of the disc of illumination, so far as due to this cause, is correspondingly more abrupt. The fact of the diminution of illumination towards the margins was noted in the sixties and discussed by Setzval, Bow, Grubb, and Goddard. The effect of the term $\cos u \,.\, \cos^3 u^1$ cannot practically be prevented: and accordingly the remedy appeared to be to diminish the illumination axially, either by special apertures or by reducing the intensity of the axial rays.

The author gives an account of the remedies suggested in past years by Grubb, Slight, R. H. Bow, De la Noë, and A. Miethe.

A. D.

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245. *Monochromatic Illumination.* **R. Straubel.** (Wied. Annalen, 66. 2. pp. 350–352, 1898.)—The author proposes the use of two prisms in order to produce monochromatic light without turning the collimator or the telescope. The two prisms are mounted face to face, and one of them can be turned in a plane parallel to one of its faces, thus changing the angle and consequently also the dispersion of the prism. E. E. F.

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246. *Magnetic Rotatory Polarisation.* **H. Becquerel.** (Comptes Rendus, 127. pp. 647–651, 1898.)—Reference is made to the recent experiment of MM. Macaluso and Corbino (C. R. 127. p. 548) which was as follows: Through the pierced armatures of an electro-magnet placed between two nicols, was made to pass, parallel to the magnetic field therein, a beam of white light that was analysed by means of a spectroscope of high dispersive power; between the armatures was placed a sodium flame, and when the current was started round the electro-magnet there was seen to appear on each side of the two absorption bands D_1 and D_2 formed in the spectrum, bands alternately dark and bright which are displaced when the analyser is rotated. These bands are due to a phenomenon of magnetic rotatory polarisation; they constitute

on each side of each of the D rays a channeled spectrum, showing that across the sodium flame the radiations which are in the immediate neighbourhood of each absorption band undergo a considerable magnetic rotation which increases in proportion to the nearness of their wave-length to that of the absorbed ray. The author has repeated and extended these observations, and connects them with a result to which he has been led, that the magnetic rotatory powers of bodies must be proportional to a function of their magnetic properties and to the expression $\lambda \frac{dn}{d\lambda}$, in which λ denotes the wave-length and n the corresponding index of refraction. (See 1898, Abstract No. 115.) The phenomenon observed by Macaluso and Corbino would appear to indicate that in the immediate neighbourhood of the bands of absorption of an incandescent vapour the value of $\frac{dn}{d\lambda}$ must be considered as becoming infinitely great. J. J. S.

247. *Mounting of Rowland Grating.* **W. E. Adeney** and **J. Carson.** (Phil. Mag. 46. pp. 223–227, 1898.)—The well-known mounting described by Ames for the Rowland concave grating spectrometer was adopted, but special provision was added to allow of the instrument being used in an ordinary lighted room, instead of the room acting as the camera as is usually the case when these instruments are used. The ways from the slit to the grating, and from the grating to the camera, were provided with wooden tubes having sliding parts so that when the instrument was adjusted for the part of spectrum required, the whole path of the light could be enclosed.

The arrangement seems perfectly satisfactory, as plates have been exposed for upwards of six hours on bright days without the plates becoming fogged, and of course the accompanying convenience of working in a well-lighted room needs no emphasising. C. P. B.

248. *Absorption by Uranyl Salts.* **E. Deussen.** (Wied. Annalen, 66. 5. pp. 1128–1148, 1898.)—The author investigates the absorption bands of uranyl salts in various solvents and endeavours to trace connections between their positions and the properties of the solvent. He finds that the various salts show some relation between solubility and absorption, the bands of the more insoluble salts tending towards greater wave-lengths, except the chloride and nitrate in glycerine. Also, the solvent exerts a marked influence upon the intensity of the absorption, as already noticed by Katz in the case of organic pigments. E. E. F.

249. *Reduction of Prismatic Spectra.* **E. Edser and C. P. Butler.** (Phil. Mag. 46. pp. 207–216, 1898.)—The authors employ the rectilinear system of interference bands formed when the beam from a continuous light source, after passing through a thin air film contained between two highly reflective surfaces, is afterwards analysed by a prismatic spectroscope. As shown by Fizeau and Foucault and more recent workers, the prismatic spectrum is under these conditions crossed by bands, the intervals between which depend on the wave-length of the light, and the relative retardation produced by the thin film, *i.e.*, on the thickness of this film. Theoretically the air film should coincide with the plane of the slit of the spectroscope, and various methods were tried to admit of this condition. By sacrificing the perfection due to this, however, it was found that the necessary apparatus and manipulation were immensely reduced, and the adopted plan is simply to support the film as close as possible to the slit-jaws. Except with spectrometers of the highest power it is difficult to detect the inaccuracy introduced.

The air film is obtained by placing two plane parallel plates of glass together, the surfaces in juxtaposition being silvered so that about 75 per cent. of the incident light is reflected. Bands can be obtained without the surfaces being silvered, but Fabry and Perot have demonstrated the greatly enhanced contrast produced by silvering the plates used for interference phenomena.

Examples of the reduction of a spectrum of iron are given, in which it appears that with the fineness of bands they used, the limit of error was not more than 0·5 tenth-metre. Two methods of reduction are shown. First, where only few lines are present, they can be reduced by the simple formula giving wave-lengths direct. Second, where many lines are required, the formula is transposed by substituting the reciprocal of the wave-length, *i.e.* wave frequency, for wave-length, and it is shown that in this case the curve representing the bands becomes a *straight line*, which can be drawn once for all very accurately on a large scale. The frequencies of the various lines can then at once be determined from their co-ordinates with respect to this line. A reproduction of the photograph measured is given in the paper. C. P. B.

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250. *Interferential Spectroscopy.* **Jobin.** (Paris Soc. Franc. Phys. Bull. 116. pp. 7–9, 1898.)—In describing a new instrument made to the design of Fabry and Perot, the author of the present paper brings together many facts from disconnected papers by these two physicists, and the article will be useful in saving the time necessary for reference to the individual papers. C. P. B.

251. *Ionic Velocities in Röntgenised Gases.* **J. Zeleny.** (Phil. Mag. 46. pp. 120–154, 1898.)—There is a difference of velocity between the positive and negative ions. The method of research is based on opposing a stream of gas to the velocity due to the electric forces. Let H be the velocity of this stream of gas; and let u, v, be the velocities of positive and negative ions respectively under a unit potential gradient, so that the actual velocities of these ions are $u.\,U/d$ and $v.\,U/d$ respectively, where U is the potential difference and d the distance across which it acts. Then if $H = u\,U/d$, the positive ions could be brought to a zero resultant velocity: if the potential difference be adjusted to V so that $H = v\,V/d$, an equal gas velocity H would bring the negative ions to a zero velocity: and then $u/v = V/U$. Experimental difficulties are discussed and apparatus explained. A type of tube is figured (page 126) which has been found to give almost constant Röntgen radiation. The following table gives the ratio between the greater velocity of the negative and the lesser velocity of the positive ion.

Air, N & O	1·24 ± ·005	Carbon dioxide, CO_2	1·00 + ·005
Oxygen, O	1·24 ± ·005	Ammonia, NH_3...	1·045 ± ·015
Nitrogen, N	1·23 ± ·01	Acetylene, C_2H_2...	0·985 ± ·015
Hydrogen, H ...	1·14 ± ·01	Nitrogen monoxide, N_2O	1·105 ± ·01
Coal gas: H and others	1·15 ± ·01		

When the E.M.F between two plates is alternating, the Röntgenised air between has its positive and negative ions put into oscillation; but the negative ions are drawn towards the plates from greater distances than are the positive ions and they gather near the plates while the central bulk of the gas becomes positively charged, so that if blown upon a conductor it will charge this. But if the distance between the plates be reduced to the amplitude of the oscillation made by each positive ion at each alternation of the E.M.F., there is no such separation, and the air when blown upon a conductor does not charge it. This gives a datum for ascertaining the actual velocity of positive ions. A metal placed in air which is, or recently has been, exposed to Röntgen radiation receives a negative charge while the air itself remains positively electrified; for the negative ions more rapidly diffuse towards the metal than the positive do, and a larger number of positive ions are left in the air. Sufficient time must be allowed for this action, but too much time tends again to equalise matters. With carbonic acid, in which the ion-velocities are equal or nearly so, this effect is inappreciable. Air charged negatively discharges faster to a surface than when charged positively (Rutherford); a consequence of the greater velocity of the negative ions. The distribution of electrification and the true local potential-gradients in a gas between two plates are discussed. As the difference of potential increases, the charge at the plates increases and also the charged area or volume of gas increases, the charged ions not being now gathered at the respective plates. A polarisation effect has been obtained. The differences in the velocities point towards differences in the sizes of the ions. A. D.

252. *Röntgen Rays and Spark Discharges.* **H. Starke.** (Wied. Annalen, 66. 5. pp. 1009–1013, 1898.)—Röntgen rays reduce the retardation of spark discharges, just as ultra-violet rays do. The maximum effects of the two kinds of radiation nearly coincide. They probably consist in the total elimination of the retardation. E. E. F.

253. *Visibility of Röntgen Rays.* **E. Dorn.** (Wied. Annalen, 66. 5. pp. 1171–1176, 1898.)—Experiments with a totally colour-blind person show that a colour-blind eye may be very sensitive to Röntgen rays. In the case described, the rays appeared of a nearly blinding intensity to the subject, while they were only faintly luminous to the ordinary eye. A number of experiments were made to test whether the rods or the cones of the retina were the sensitive organs in the case of X rays. The results showed that the rods are more sensitive than the cones, although the latter also perceive the rays to a lesser extent, as is proved by the sensitiveness of the yellow spot, which contains no rods. E. E. F.

254. *Becquerel Rays.* **J. Elster** and **H. Geitel.** (Wied. Annalen, 66. 4. pp. 735–740, 1898.)—The authors have endeavoured to discriminate between the theories which attribute the origin of uranium and thorium rays to the absorption of molecular energy, to the absorption of a kind of transcendental rays, and to chemical action respectively. They used the highly efficient uranium pitch ore of Joachimsthal for the purpose. They first tried it in a vacuum, but without detecting any difference in its behaviour. Then they took the substance to the bottom of a mine, 850 m. below the surface, but without effect. If the molecular or chemical theories had been true, a difference should have been shown in a vacuum. If the rays postulated by Curie exist, they would probably not penetrate 3,000 feet of rock. The negative results leave the question open for solution. E. E. F.

255. *Photographic Action of Living Structures.* **P. Frankland.** (Chem. News, 78. p. 186, 1898.)—An account is given of experiments which show that ordinary bacterial cultures are capable of affecting photographic films, even at a distance of half an inch, whilst when placed in contact with the film definite pictures of the bacterial growths are obtained. As this action does not take place through glass it is considered due to the evolution of volatile chemical substances which enter into reaction with the sensitive film. Bacterial growths which are luminous in the dark exert a much more powerful action on the photographic plate than non-luminous bacteria, and this action can take place although a glass plate is interposed. J. J. S.

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256. *Photographic Action of Gases and Metals.* **B. von Lengyel.** (Wied. Annalen, 66. 5. pp. 1162–1170, 1898.)—Reducing gases like hydrogen have an effect upon photographic plates similar to that of light, since they produce a modification of silver bromide which is easily reduced by the ordinary developers. The effect of metals like zinc, platinum, and palladium is explained by the fact that they liberate hydrogen from moist air and thus indirectly influence the photographic plate. Uranium and thorium compounds alone give out a radiant energy.

E. E. F.

HEAT.

257. *Dalton's Law.* **W. N. Shaw.** (Chem. News, 78. p. 185, 1898.)—Discrepancies between the sum of the partial pressures of air or nitrogen and saturated vapour, and the pressure of mixtures of the gases respectively with saturated vapour, indicating an apparent departure from Dalton's Law, were shown by Regnault to exist for water vapour; the extent of the difference being on the average nearly 0·5 mm. Regnault attributed the phenomena to the condensation of the vapour on the vertical sides of the containing tube under a pressure of vapour less than the saturation pressure corresponding to the temperature. The author discusses Regnault's explanation, and concludes that it is probably an unreal one, and that an actual divergence from Dalton's Law is indicated. The amount of the divergence, however, cannot be finally deduced from the records of Regnault's observations, and must await a repetition of such experiments in which the errors which may be due to super-saturation are guarded against. J. J. S.

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258. *Low Temperature Specific Heats.* **U. Behn.** (Wied. Annalen, 66. 2. pp. 237–244, 1898.)—Dulong and Petit's law is departed from in the case of metals more and more as the temperature falls. Between −80° and −180° the atomic heats, instead of ranging about 6·3, vary from 6·0 (lead) to 4·0 (iron). The decrease in the specific heat is greatest in those metals which have a high specific heat at high temperatures. This indicates the possibility of all metals having the same specific heat at the absolute zero. That specific heat is probably itself zero.

E. E. F.

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259. *Specific Heat of Liquids.* **E. Gumlich** and **H. F. Wiebe.** (Wied. Annalen, 66. 3. pp. 530–534, 1898.)—The Andrews-Pfaundler method of determining specific heats of liquids by immersing in them a hot bulb containing mercury, and allowing it to give off heat to the liquid until the mercury has attained a certain position in the stem of the bulb, is subject to the error that though the mercury may have apparently fallen through the same range of temperature, the final temperatures of the two liquids compared may not be the same. Hence the contraction and capacity of the glass vessel is different, and affects the position of the mercury. E. E. F.

260. *Variation of γ with Temperature.* **A. Leduc.** (Comptes Rendus, 127. pp. 659–662, 1898.)—The numerical results of a former paper (see 1898, Abstract No. 383), are here slightly corrected and augmented. The second column represents the speed of sound in decimetres per second, and the third the ratio γ of the isopiestic and isometric specific heats.

Air at	0° C.	3318	1·4040	CO at 0°	3370	1·401
„	100° C.	3878	1·4031	N_2O „	2596	1·324
CO_2 at	0° C.	2593	1·3190	NH_3 „	4159	1·336
„	100° C.	3002	1·2827	C_2H_4 „	3158	1·250

Thus, though γ falls for CO_2 as the temperature rises, it scarcely varies for air; for a perfect diatomic gas $\gamma = 1·4$; for a perfect triatomic gas $\gamma = \frac{4}{3}$. The author proposes to show later that in the last case $\gamma = 1 \times \frac{2}{3} \cdot \frac{4}{10} = 1·267$, and that $\gamma = \frac{5}{3}$ does not characterise a perfect monatomic gas. R. E. B.

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261. *Mechanical Equivalent of Heat and Specific Heats of Gases.* **A. Leduc.** (Comptes Rendus, 127, pp. 860–862, 1898.)—Calculating J from the equation $J\,(C - c) = T\,(dp/dt)\,(dv/dt)$ with the characteristic given by equations (5) and (4) of Abstract No. 383, 1898 (the functions occurring in which are defined in Abstract No. 300, 1898), and using his previously obtained values for air, viz., $\gamma_0 = 1·404$, $\gamma_{100} = 1·403$, $C_0 = C_{100} = ·239$ (see 1898, Abstract No. 1234) the author obtains for $J.10^{-6}$ the values 41·94 from air at 0°, and 41·84 from air at 100°, or in the mean, 41·89. Applying this result to CO_2 with the values $\gamma_0 = 1·319$, $\gamma_{100} = 1·283$, he finds $C_0 = 0·193$, $C_{100} = 0·207$; the former lies between the values given by Regnault and Wiedemann, but the latter is considerably less than either. R. E. B.

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262. *Thermal Properties of Gases and Liquids.* **S. Young.** (Chem. News, 78. pp. 200–201, 1898. Rep. Brit. Assoc. 1898, pp. 831–834.)—The ratio of the actual density of a saturated vapour to its theoretical density should, on van der Waals' theory, be the same for all substances at corresponding pressures, and at the critical point should, with O. E. Meyer's correction, be $\frac{8}{3} \times \sqrt{2} = 3·77$. Twenty-six substances were examined, and they grouped themselves as follows: for benzene, its four monohaloid derivatives, ether, the tetrachlorides of carbon and tin, and four paraffins, this ratio at the critical point is in the mean 3·77; for ten esters it varies from 3·87 to 3·95; for the lowest three alcohols it is from 4·02 to 4·52; and for acetic acid it rises to 5. This points to polymerisation at the critical point to a less or greater extent.

An accurate experimental determination of the critical specific volume cannot apparently be obtained: it may be estimated on the assumption of Cailletet and Mathias' law of diameters, viz., that the mean of the densities of a saturated vapour and its liquid is a linear function of the temperature, which was confirmed for all the compounds examined except the alcohols. The experiments furthermore confirmed the view, which of late has been contested, that the vapour pressure of a *pure* substance is independent of the relative volumes of liquid and vapour present.

R. E. B.

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263. *Kinetic Theory of Liquids.* **C. Dieterici.** (Wied. Annalen, 66. 5. pp. 826–858, 1898.)—This work is an attempt to formulate a kinetic theory of liquids. It is the result of a conviction as to the possibilities of bringing the principles of the new theory of solutions into harmony with the well-established theorems of the kinetic theory of gases. Those attempts which have been hitherto made have often led to contradictory results. On closer examination, the contradictions turn out to be only apparent, but this does not become evident until the observations are numerically compared with the theoretical equations, and hence the present work is not so much a mathematical theory as an empirical calculation concerning the necessary theoretical foundations. In the first three divisions the liquids are treated as ideal gases, and the calculations familiar from the kinetic theory of such gases are applied to liquids. The conclusions resulting as to vapour pressure and heat of vaporisation do not agree with actual facts. The author therefore discusses the various possibilities of amplification and shows that only the considerations of space extension of the molecules, first introduced by van der Waals, are capable of leading any further. But this is only made possible by attaining a more definite conception of the mechanism of evaporation, in which the author assumes the molecules to be infinitely hard, or constructed so that the effects of impact are propagated through the mass of a molecule in an infinitesimal time. The expression for the heat of evaporation thus obtained has a clear and definite sense, and corresponds very fairly with experience. Also, it admits of an immediate application to solutions and leads to a kinetic theory of osmotic pressure, the most important quantity in the new theory of solutions. A numerical calculation of the expressions and their application to experimental results is, however, attended with difficulties, and can only be carried out when further information is obtained with regard to the size of the molecules of both the solvent and the solute. A further development of the author's attempt will, of course, introduce emendations of the suppositions made, but he at least succeeds in showing that even with our present knowledge a treatment of liquids according to the kinetic theory of gases is possible, and leads to tangible results.

E. E. F.

SOUND.

264. *Circular Chladni Plates.* **J. Zenneck.** (Wied. Annalen, 66. 1. pp. 170–176, 1898.)—The sand figures obtained with Chladni plates differ from those obtained by theory owing to lack of perfect symmetry of the plates used. There are always two definite positions of the radial nodal lines in which a simple vibration, free from beats, may be obtained with stationary lines. The lines in one chief position bisect the angles between the lines in the other chief position. If the radius originally fixed does not happen to coincide with one of these chief positions, both systems of lines occur at the same time, and begin to oscillate about the nearest chief position. If the plate is capable of rotating, the plate itself oscillates, or at all events it turns slowly in one direction, and returns as the vibration dies out. E. E. F.

265. *Tuning Plates.* **F. Melde.** (Wied. Annalen, 66. 4. pp. 767–780, 1898.)—In order to avoid the difficulties attending the measurement of the pitch of high tuning-forks and even their theoretical values, the author substitutes small and thick circular Chladni plates capable of giving notes up to 30,000 vibrations per second. The pitch may be accurately calculated from the dimensions by Chladni's formula. The only difficulty remaining is to prove that the plate vibrates at all, since the ear is incapable of perceiving notes of the highest pitches. The author uses his resonance method, which consists in transferring the vibrations by means of a lever to a rod or a membrane, on which the vibrations are indicated by nodal lines or circles. He finds the theoretical and experimental values to agree within about 2 per cent.

E. E. F.

266. *Velocity of Propagation of Discontinuities.* **P. Vieille.** (Comptes Rendus, 127. pp. 41–43, 1898.)—On sharpening the explosion of fulminate by tightly packing it, the velocities of propagation rise to 1100 metres in air, 800 in carbonic acid, and 2000 in hydrogen, with a charge of 0·63 gramme of fulminate. This velocity rapidly falls off as the wave travels, and the impact of the wave loses its original percussive character. A. D.

ELECTRICITY.

267. *Theories of Lorenz and of Larmor.* **A. Liénard.** (Écl. Électr. 16. pp. 360-365, 1898.)—Liénard points out certain difficulties to which in his view Larmor's theory is subject. If A B C denote components of magnetisation, $\alpha\ \beta\ \gamma$ those of magnetic force, *a b c* those of magnetic induction, of any system of magnets, the energy of system (1) in the field of system (2) is

$$-\int(A_1\alpha_2+B_1\beta_2+C_1\gamma_2)\,d\omega$$

over all elements of volume $d\omega$. In this he substitutes for A B C from the known relations $a=\alpha+4\pi A$, &c.

It is then proved that

$$\int(a_1\alpha_2+b_1\beta_2+c_1\gamma_2)\,d\omega=0$$

Whence he obtains for the energy in question the two equivalent expressions—

$$\frac{1}{4\pi}\int(\alpha_1\alpha_2+\beta_1\beta_2+\gamma_1\gamma_2)\,d\omega \qquad (1)$$

and

$$-\frac{1}{4\pi}\int(a_1a_2+b_1b_2+c_1c_2)\,d\omega \qquad (2)$$

It follows that the energy of a system of magnets may be put in the form

$$W=\frac{1}{8\pi}\int(\alpha^2+\beta^2+\gamma^2)\,d\omega \qquad (1)$$

When we pass to the equivalent currents, the components of magnetic induction *a b c* have, according to M. Liénard, the same value for the currents as for the magnets, and the energy of the system of currents is

$$W=\frac{1}{8\pi}\int(a^2+b^2+c^2)\,d\omega \qquad (2)$$

It is then shown that the two values of W differ by the constant

$$2\pi\int(A^2+B^2+C^2)\,d\omega$$

Liénard says that according to Larmor's theory the system of magnets and that of the equivalent currents have energies of the same sign.

To overcome the difficulty he suggests that the elementary molecular currents are not, as in Larmor's theory, rigorously constant, but are subject to induction. He then considers the effect from this point of view of Larmor's theory that the molecular currents are currents of convection of moving ions or electrons. Lorenz's theory, according to M. Liénard, is not subject to this difficulty.

Next is considered Larmor's view that the magnetic field produced by the displacement of an ion is an indirect effect of the Maxwell current of displacement $f\,g\,h$. A charged body symmetrical about an axis revolves with uniform velocity. The displacement is then constant and there should, according to Larmor, be no magnetic field. But this does not agree with Rowland's experiment. Liénard criticises Larmor's method of avoiding this difficulty, which, he says, does not affect Lorenz's theory. S. H. B.

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268. *Irreversible Radiation.* **M. Planck.** (Berlin, Akad. Sitzber. 34. pp. 449–476, 1898.)—In his former communications on this subject (see 1898, Abstract No. 631) Planck investigated the concentric electromagnetic waves in a hollow sphere bounded by a reflecting surface at the centre of which is a small resonator. The resonator, absorbing and emitting energy, affects the radiation, and in an irreversible way, because the oscillations of intensity are generally less for the emitted than for the entering waves. Certain classes of waves have to be excluded from consideration. The conception is introduced of "natural" radiation which always goes on irreversibly.

It is necessary for this conception to introduce the radiation intensity for a defined wave-length. Planck discusses this question.

In the fourth section is investigated the intensity of the radiation inwards and outwards, and the energy of the resonator.

In the fifth section the intensity of radiation belonging to waves of given wave-length.

In the sixth section he discusses the relations between the vibration of the resonator and the intensities of the radiation inwards and outwards. He defines the "natural" radiation. The criterion of irreversibility is that there should exist a function whose value is completely determined by the state of the system at any instant, and whose rate of change with the time is always of the same sign, that is an entropy function. Such a function is proved to exist for Planck's radiations. S. H. B.

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269. *Capacity of Two Spheres in Contact.* **R. H. Jude.** (Phil. Mag. 46. pp. 254–258, 1898.)—This note discusses the valuation of Maxwell's expression for the electrostatic capacity of two spheres in contact. This cannot be effected by ordinary algebraic methods except when the diameters of the spheres are

equal. The author here obtains the desired summations in terms of the *Eta Function* as follows:—

$$\frac{Q_a}{V}=\frac{a\,b}{a+b}\,H\left(\frac{b}{a+b}\right); \qquad (1)$$

$$\frac{Q_b}{V}=\frac{a\,b}{a+b}\,H\left(\frac{a}{a+b}\right); \qquad (2)$$

and of course

$$C=\frac{Q_a+Q_b}{V}; \qquad (3)$$

Where the Q's denote the charges on the spheres of radius a and b, V their common potential, C the capacity of the pair and the Eta Function is defined by the equation

$$-H(n)=1-\frac{1}{n}+\frac{1}{2}-\frac{1}{n+1}+\frac{1}{3}-\frac{1}{n+2}+ \qquad (4)$$

E. H. B.

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270. *Capacity of Wires.* **W. Moon.** (Elect. Rev. 43. pp. 478–480, 1898.)—The limits of the capacity of multiple cables can be stated; thus the capacity between a wire X and a number of other wires and the earth cannot be as great as twice the capacity between X and the nearest wire. In the case of wires on poles, the capacity between X and the remaining wires and earth is not as great as that between X and an infinite plane at the distance of the nearest wire. The capacity between one wire and any system of wires and the earth could in no case be as great as twice the capacity between one wire and the earth. In a perfect telephone looped circuit, the effective capacity of one wire may be taken as the sum of the capacity of either wire with the remainder and earth, and the capacity between the two wires and the loop. M. O'G.

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271. *Influence of Mechanical and Electric Stress on Capacity.* **U. Panichi.** (N. Cimento, 8. 4. pp. 89–96, 1898.)—An increase of specific inductive capacity with traction has been deduced from theory by Lippmann, and found experimentally by Dessau; Cantone, on the other hand, has shown that a decrease of dielectric constant ought to occur in a direction normal to that of traction, and this has been verified by Corbino. The author has examined the changes of volume produced by traction and by electric charge respectively, in a condenser consisting of a cylindrical tube of ebonite, separating two coatings of mercury; he has also investigated the relation between the stretching force and the consequent variation of specific inductive capacity. It is found that the change of volume of the dielectric is proportional to the stretching force applied. The electric charge from a Holtz

machine produces small increases of volume, which are slightly greater when the condenser has been charged for some time; the volume becomes constant after about five minutes' charging.

For experiments on the effect of stress on specific inductive capacity, the condenser is charged from 150 Daniell cells; it is then connected with an electrometer and stretched by various weights. The readings of potential indicate that the inductive capacity of ebonite diminishes with traction, and, within the limits of the experiment, proportionally to the traction. J. L. H.

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272. *Dielectric Constants.* **J. A. Erskine.** (Wied. Annalen, 66. 2. pp. 269–283, 1898.)—If C_1 and C_2 are capacities inserted in a primary and a secondary circuit respectively, and i_1 and i_2 the currents, the author proves that i_2 changes very rapidly with C_2 when C_1 has certain values. Hence, if a suitable current indicator is available, the mutual influence of two circuits may be used for comparing two capacities with great accuracy, and hence also for the determination of dielectric constants. Such an indicator the author found in a set of magnetised bits of steel wire, only 1 cm. long. The primary current consisted of the discharge of an influence machine. The unknown capacity was determined by measuring the distance between the plates of a Kohlrausch condenser, when that and the condenser of unknown capacity produced the same demagnetisation of the needles. E. E. F.

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273. *Contact Electricity.* **A. Heydweiller.** (Wied. Annalen, 66. 3. pp. 535–539, 1898.)—The author tests Coehn's rule, according to which a body with a higher dielectric constant is positively charged by contact with a body of a lower dielectric constant, for liquids and solids, by introducing minutely subdivided metals into a narrow tube containing an electrolyte, made up of a mixture of water and acetone, or acetone and alcohol, in proportions suitable for obtaining a definite dielectric constant between 5 and 70. The contact electrification between the metal and the liquid is indicated by the motion of the metallic fragments in the tube on passing the current. Platinum shows electrification in pure chloroform, but negative in all other dielectrics. Gold, tin, cadmium, zinc, and aluminium are increasingly positive. An exception to Coehn's rule occurs in the alcohols and in amyl acetate. E. E. F.

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274. *Point Discharges.* **K. Wesendonck.** (Wied. Annalen, 66. 2. pp. 341–345, 1898.)—One terminal of a Voss machine is put to earth, while the other leads to a spark gap, beyond

which a fine needle is attached to the wire, which is also put to earth. Opposite the needle-point is mounted a plate connected with an electroscope, the outer cover of which is put to earth. On working the machine the plate is always charged positively, as in Tesla's corresponding experiment. On introducing a suitable self-induction, however, the plate is charged with the same charge as that of the terminal used. The difference between the two cases may be strikingly shown by introducing a closely wound coil of wire as a self-induction, and then pulling out the coil to a greater length, thus lessening its inductance. The author explains the effect by assuming that the negative discharge suffers more retardation than the positive discharge.
E. E. F.

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275. *Point Discharges.* **E. Warburg.** (Wied. Annalen, 66. 4. pp. 652–659, 1898.)—Let a needle-point be mounted opposite a metallic surface earthed through a galvanometer. If the needle-point is then maintained at a potential which exceeds a certain value the galvanometer indicates a constant current traversing the air between the point and the metallic surface. The author asks what time elapses between the establishment of the proper difference of potential between needle-point and surface and the passing of the discharge. He mounts a fine platinum point in the centre of a nearly closed metallic sphere, and determines the current after various intervals of charging. He finds that the discharge attains its full value 0.007 secs. after establishing the proper difference of potential, and that, therefore, the air does not require more than that short interval to acquire its full conductivity. The retardation which attends spark discharges between spheres is not observed in this case. E. E. F.

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276. *Stratified Brush Discharge.* **M. Toepler.** (Wied. Annalen, 66. 4. pp. 660–675, 1898.)—A spark gap and a large liquid resistance are inserted in the circuit of a 60-plate Toepler machine, the capacities in the circuit being kept small. Then, while the current is feeble, the discharge takes the form of the ordinary brush discharge. When the current strength attains a certain minimum limit the brush discharge is displaced by a stream of sparks. Instead of the low humming, a rattling sound is heard, rising in pitch as the current increases. On reaching a certain higher limit a nearly continuous brush light arc takes the place of the spark discharge, characterised by a great evolution of heat and by a stratification resembling that already described by the author in the case of a large battery of Leyden jars. This brush light burns almost noiselessly. A further increase in the current strength does not produce any further change. On gradually reducing the current the same phenomena are noticed

in the reverse order. Experiments with various gaps show that the lower limit between brush and spark discharges is nearly independent of the size of the gap, but when the current falls below a certain small minimum value none but spark discharges can be produced, however large or small the gap. If the anode is pointed the brush-light arc consists of bright, whitish-violet kathode light, a second layer of brick-red light, scarlet positive light, and anode glow light. The analogy between open-air and vacuum discharges is further strengthened by the fact that the Wiedemann-Hittorf law of vacuum discharges, according to which the difference of potential at which discharge sets in is independent of the current strength, also holds for these open-air discharges. E. E. F.

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277. *Magnetic Deflection of Discharges.* **J. Precht.** (Wied. Annalen, 66. 4, pp. 676–697, 1898.)—Magnetic deflection is observed not only in vacuum discharges, but also in open-air spark, glow, and brush discharges. If the anode is pointed, and the kathode blunt, the length of gap 8 mm., and the difference of potential 8,600 volts, a field of 7,000 units produces a very decided deflection of the path of the sparks, accompanied by a fall in the potential by about 1,000 volts. The deflection is limited to that portion of the spark which lies between the centre and the kathode, and is accompanied by an increase of brightness. When the gap is widened, brush discharge sets in, but the spark discharge is restored by a strong magnetic field. On still further widening, the brush discharge is re-established, but the magnetic field alters the oval shape of the brush, and concentrates it into the equatorial plane. At the same time a plane anode is strongly etched. E. E. F.

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278. *Frequency of Electric Sparks.* **B. Walter.** (Wied. Annalen, 66. 4. pp. 636–648, 1898.)—The author mounted a sensitive plate upon a little car moving on rails and driven by a falling weight. The rotary interrupter of the induction coil was worked at such a rate that at least two sparks were recorded on the moving plate. This, while ensuring a record, also furnished a measure of the time. The records all agree in showing several successive discharges at intervals of $2{\cdot}7 \times 10^{-4}$ sec. The successive partial discharges, though all in the same direction, show an alternate weakening and strengthening, due to the surging of the primary current in the condenser. Further analysis shows that every spark is preceded by several brush discharges. Each brush discharge is separated from the preceding one, which is usually of the opposite sign. These brush discharges, also seen in lightning photographs, appear as small appendages to the main spark in the ordinary photographs. They serve as pilots for the spark discharge. E. E. F.

279. *Gliding Sparks on Glass.* **M. Toepler.** (Wied. Annalen, 66. 5. pp. 1061–1080, 1898.)—Spark discharges may be made to pass along surfaces of gypsum, water, lampblack, metallic powders, and other substances. Those passing along glass surfaces have the advantage of always passing under practically the same conditions, since even the roughening of the surface by strong sparks does not sensibly affect them. Hence such gliding sparks serve well to show the influence of various kinds of electric discharges upon the length of spark obtainable. The author distinguishes two kinds of gliding sparks. The first kind is produced by a single application of the requisite difference of potential to the electrodes. The second kind is due to the application of a rapidly oscillating E.M.F. The glass surface must be perfectly clean. Two needle-points are pressed upon it, one of them connected with a strip of tinfoil stuck under the plate and reaching from that point to a place opposite the other needle-point. As the length of spark increases, the additional potential required to extend it by another cm. becomes less and less. To obtain gliding sparks of the second kind, the author mounts a high-set inductance in parallel with the glass plate. In this case the increase in spark-length is proportional to the increase of potential. E. E. F.

280. *Potential Gradients in Vacuum Tubes.* **E. Wiedemann** and **G. C. Schmidt.** (Wied. Annalen, 66. 2. pp. 314–340, 1898.)—The authors investigate the influence of the source of current, of heat, magnetism, ultra-violet light, and the photo-luminescence of the gas itself upon the potential gradient in a vacuum tube. They find that the luminous appearances are characteristic of the discharge potential, even under very diverse conditions. The potential gradient in the positive light column is largely independent of the width of the tube and the type of the discharge. Ultra-violet light and photo-luminescence are practically without effect upon the potential gradient. The heating effects in the glow light are quite out of proportion to the potential gradient there, probably owing to the fact that some rays are produced at the kathode and absorbed in the glow light. E. E. F.

281. *Air under powerful Electric Stress.* **J. Trowbridge.** (Phil. Mag. 46. pp. 243–245, 1898.)—Experiments on air exposed to an E.M.F. of about 3,000,000 volts are described. The initial resistance of air under this stress is found to be greatly reduced. The curve expressing the relation between spark-length and the E.M.F. departs from a straight line beyond 1,200,000 volts and approaches the axis expressing the potential difference. The extreme length of spark in air which was obtained was 6½ feet, whereas a length of 10 feet would have been reached if

the spark-length had remained proportional to the potential difference. This departure from proportionality is due to the increased conducting-power of the air. The initial resistance of highly rarefied media also diminishes in a similar manner.

J. J. S.

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282. *Magnetic Deflection of Kathode Rays.* **W. Kaufmann.** (Wied. Annalen, 66. 4. pp. 649–651, 1898.)—In reply to certain criticisms advanced by A. Schuster, the author emphasises the probability that the whole of the electric energy in a vacuum tube is converted into kinetic energy, and the importance of repeating the experiments hitherto made for the determination of e/m with the greatest attainable accuracy. E. E. F.

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283. *Reaction Pressure of Kathode Rays.* **E. Riecke.** (Wied. Annalen, 66. 5. pp. 954–979, 1898.)—The investigations were carried out by means of a radiometer whose vanes were made into kathodes. The motion of the latter in coming to rest after the current had been interrupted was particularly noted, in order to gain an idea of the resistance which they had to encounter in revolving. The reaction pressure was found to be proportional to the current strength. The latter was furnished by a 40-plate Toepler influence machine, which gave a current of about 3×10^{-6} electrostatic units. The reaction pressure was 0·04 c.g.s. units. When the pressure is calculated from the heat of impact of the particles upon the glass wall, it comes out as 0·07 units.

E. E. F.

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284. *Attenuation of Electric Waves along a line of Negligible Leakage.* **E. H. Barton.** (Phil. Mag. 46. pp. 296–305, 1898.) —This paper gives the results of an experimental determination of the attenuation of high-frequency waves along a line practically devoid of leakage and compares the value found with that deducible from the theories of Heaviside and Rayleigh which are approximately applicable to the case. When there is no leakage the theoretical attenuating factor is $e^{-R'x/2Lv}$, where R′ is the effective resistance and L the inductance of the pair of wires per unit length, x the distance along the line in cm., and v the speed of light. Rayleigh's high-frequency formula for an isolated wire and a simple harmonic wave train uniformly maintained gives for the present case $\frac{R'}{R} = 31{\cdot}6$, R being the resistance to steady currents. The experimentally determined value of the attenuation factor, viz., $e^{-0{\cdot}0000013x}$, is about double that which would be expected on the theories just quoted. The possibility of

errors in the experiment are discussed and shown to be probably negligible. It is then remarked (1) that in the line used the wires are side by side 8 cm. apart instead of being each isolated, and (2) that the train of waves passing along them is rapidly damped as the primary oscillations die out instead of being maintained of constant amplitude. It thus appears probable that the required modifications of the theory would yield a value of the attenuation more nearly in accord with the experimental one.
AUTHOR.

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285. *Electric Oscillations.* **M. Abraham.** (Wied. Annalen, 66. 3. pp. 435–472, 1898.)—A full treatment of the fundamental and higher oscillations of a straight rod by Maxwell's electrodynamic theory. E. E. F.

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286. *New Form of Hertz Experiments.* **J. Precht.** (Wied. Annalen, 66. 5. pp. 1014–1019, 1898.)—When a constant current from an influence machine is passed between a pointed anode and a blunt kathode, and the electrodes are separated to such an extent that only a faint glow discharge passes, that glow discharge may be converted into a shower of sparks by breathing up the spark gap. A similar effect is obtained by means of electromagnetic waves received by a parabolic mirror, when the resonator sheets are put in metallic connection either with the electrodes, or with two wires mounted very near the kathode, so that small sparks may pass from either of them to the blunt kathode. The spark gap then forms a sensitive instrument for the detection and demonstration of the classical Hertz effects. It has the further advantage of returning at once to its previous condition when the waves cease to impinge upon it. The effect is quite distinct from that of ultra-violet light. At the time that the glow discharge is replaced by a spark discharge, the difference of potential is considerably reduced between the electrodes. This is indicated by an electrometer connected in parallel, and serves to make the effect of the waves still more evident. E. E. F.

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287. *High-Frequency Oscillators for Electro-therapeutic Purposes.* **N. Tesla.** (Elect. Engin. N.Y. 26. pp. 477–481, 1898.)—Arrangements are described by which the oscillatory discharge of a condenser, charged by a high-frequency alternator, may be sent through the primary circuit of an induction coil. The terminals of the secondary circuit are applied to the body of the patient, or one of them may be left insulated. The induction coil differs from the ordinary form, having circuits of very small resistance and few turns. The author also describes a rotary make and break capable of charging and discharging a condenser

10,000 times per second; the contacts are made by directing a stream of mercury against a metal disc carrying thin contact-blades. J. L. H.

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288. *Electric Dispersion.* **K. F. Löwe.** (Wied. Annalen, 66. 3. pp. 390–410, and 4. pp. 582–596, 1898.)—For a number of esters of benzoic acid and the fatty acids the author obtains nearly the same dielectric constants for slow oscillations as Drude found for much more rapid ones. But they are smaller than those found by Tereschin. The dielectric constants of a number of organic substances possessing anomalous electric dispersion are generally much higher for slow than for rapid oscillations. The anomalous electric absorption calculated after Drude from the dispersion of the dielectric constant corresponds closely with the observed values. The electric dispersion of glasses is in general anomalous, but is much less than that quoted by J. J. Thomson. Starke's method of determining dielectric constants by immersion must be limited to bodies whose electric conductivity does not exceed a certain value indicated by theory. E. E. F.

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289. *Electric Dispersion.* **E. Marx.** (Wied. Annalen, 66. 3. pp. 411–435 and 4. pp. 597–622, 1898.)—Very short electric wire-waves may be obtained by loosening the coupling of the primary and secondary system so that the oscillations due to the primary alone may be observed. The author thus obtained distinct and easily manipulated wire-waves not exceeding 4 cm. in length. He succeeded in mapping out completely the electric dispersion in water, benzol, and ethyl alcohol. Benzol only shares a single absorption band, from which the inductance of the benzol molecule can be calculated. In the electric spectrum of water the maxima and minima of the refractive index occur approximately in double octaves. In ethyl alcohol, a difference in the concentration of 1 per cent. may mean a change in the square of the electric refractive index by 35 per cent. Its dispersion may be approximately represented by a formula in which its proper oscillation is entirely neglected. E. E. F.

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290. *Polarised Electromagnetic Waves.* **K. Waitz.** (Wied. Annalen, 66. 2. pp. 308–313, 1898.)—The author's observations differ somewhat from those of Latrille (see 1898, Abstract No. 1210). According to the latter, the electromagnetic energy transmitted by a metallic slit always increases in proportion to the length of the slit. Waitz, on the other hand, finds a periodic increase and diminution as the length of the slit is enlarged. The minima are very pronounced, and closely approach zero. A

maximum transmission occurs when the stationary wave at the slit has the same length as the resonator and electrometer combined. The first minimum occurs at a length of slit which is double that of the first maximum. The slit vibrates in two halves, and there is a node at the centre. When the resonator is displaced towards the end of the slit, so as not to be at the node, the deflection of the electrometer increases. E. E. F.

291. *Electromagnetic Waves and Conductivity of Selenium.* **B. Agostini.** (N. Cimento, 8. 4. pp. 81–89, 1898.)—The ends of a glass tube of 1·5 mm. diameter are closed by copper electrodes, enclosing between them fragments of amorphous selenium. By prolonged heating and slow cooling the selenium is crystallised and the tube is then inserted in one arm of a Wheatstone's bridge. Exposure to light diminishes the resistance to nearly half the value in the dark, namely from 110,000 to 62,000 ohms. The tube is then placed at the focus of a parabolic mirror which receives parallel rays from a second parabolic mirror having a Righi oscillator at its focus; the waves used are of short length. The results show that the conductivity of the selenium sometimes increases and sometimes decreases on exposure to the electromagnetic waves; the variation observed is exceedingly small in amount and may be due to errors of observation. The change of resistance is not produced as suddenly as in the case of light and the original resistance is not recovered so quickly when the radiation ceases; the variations observed may therefore be the result of temperature-changes during the experiments. J. L. H.

292. *Coherers.* **E. Aschkinass.** (Wied. Annalen, 66. 2. pp. 284–307, 1898.)—The view of the action of a coherer according to which minute sparks weld the coherer particles temporarily together, does not account for the anomalous behaviour of PbO_2 powder, whose resistance is greatly increased by the influence of electric radiation. Further, when the air is exhausted from a coherer tube to such an extent that all spark discharges cease to pass, its sensitive reaction takes place as before, though the spark explanation hardly holds good. A chemical action is rendered improbable by the fact that chemically cleaned copper gives a good coherer action. The only advantage of a layer of oxide is that the pressure under which the particles are packed may be varied within wider limits. A gentle heat restores the high resistance, though the contrary effect might be expected. This action is also as yet unexplained. E. E. F.

293. *Coherers.* **O. Behrendsen.** (Wied. Annalen, 66. 5. pp. 1024–1029, 1898.)—The failure of coherers to detect and correctly indicate ordinary Hertzian vibrations is due to their extreme sensitiveness. When working with them, all single wire lengths should be avoided, and conductors always arranged on the telephone principle, since quite short lengths of a single wire are likely to absorb the waves. In order to study the reflection of electric waves at a wall, and the formation of stationary waves, the author used a coherer of powdered arc carbon. Such a coherer never has an infinite resistance, and it alters by different amounts according to the strength of the impinging wave. The author also describes a beautiful interference experiment made with a nickel coherer. The latter was mounted at a distance of 15 cm. behind a sheet of tinfoil containing two horizontal slits 8 cm. long and 3 mm. wide, which were 1 cm. apart. On working a small exciter stationed 3 or 4 m. from the sheet on the other side, the coherer tube reacted when in a horizontal position. On being raised or lowered by 1 cm. the tube ceased to react, thus indicating a dark interference line. This line was followed by a "bright" space, and that again by another interference line. E. E. F.

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294. *Conductor-resistance of Cables Corrected for Leakage.* **W. J. Murphy.** (Electrician, 41. pp. 519–522, 1898.)—A simple method of arriving at Schwendler's results. The rules are:—

I. The "fall" in C.R. due to a leak is directly proportional to the square of the conductor resistance beyond the apparent position of the leak, and inversely proportional to its apparent resistance.

$$f_A = \frac{b^2}{r'}$$

II. The apparent distance of the leak from the observer is equal to the square root of the product of the fall observed by the distant station and the apparent resistance of the leak observed by himself, or $\sqrt{f_B r''}$

III. The D.R. of the cable is equal to the square of C.R. beyond the leak divided by the observed fall, or $r' = \frac{b^2}{f_A}$

IV. The resultant leak is distant from each end inversely as the square roots of the falls.

The author proposes to make weekly records of the positions of the resultant faults. Loop localisations should be obtained with the junction earthed, as the long electrification of free loops makes accuracy difficult. M. O'G.

295. *Correction of Schaefer's Break Test for Earth Current.* **W. J. Murphy.** (Electrician, 41. pp. 716–717, 1898.)—Alluding to Schaefer (Electrician, p. 817, 1897), the coefficient of $\frac{\epsilon}{nc}$ is $\left\{ \mathrm{K}n-(\mathrm{K}+n) \right\}$ a quantity which increases by 0·009 for every tenth increase of *n*, and the correction for earth current is equal "to the earth potential expressed in millivolts divided by the stronger of the currents in milliamperes and multiplied by 0·4 if the current ratio (*n*) is about 2, by 0·5 if near 3, and by 45 if about 2·5." M. O'G.

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296. *Contact Resistance.* **E. Branly.** (Comptes Rendus, 127. pp. 219–223, 1898.)—Some metals, such as copper, zinc, brass, silver, German silver, seem to offer little resistance at their surfaces, while with others (Fe, Al, Pb, Bi) the surface resistance is very great. A column of zinc or copper discs has no electric resistance; a column of aluminium, iron, or bismuth discs offers very little resistance if loaded, but a great resistance if the discs are simply allowed to fall into place, with a shock. With bismuth an electric spark passed through deprives the column of its resistance. With mixed columns similar results are obtained. These are hardly phenomena of imperfect contact, on account of the extreme and equal polish of all the discs, but it is at present difficult to classify them. A. D.

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297. *Contact Resistance.* **F. Auerbach** and **A. Meyer.** (Wied. Annalen, 66. 4. pp. 760–766, 1898.)—Two geometrically true and perfectly polished steel spheres were pressed together, and their resistance was determined when the pressure varied. The results show that the conductivity of the surface of contact varies directly as its area, but also as the integral of the pressure. The spheres used were from 4 cm. to 10 cm. in diameter, and were pressed together with forces of 100 gr. to 1000 gr. To ensure comparable results the spheres had to be exposed to the sound-vibrations from a tuning-fork before every measurement. The effect of the pressure is, of course, to flatten both spheres to an extent depending upon their elasticity. The elasticity of the steel being known, the area and the pressure at each point are calculable. The results may be utilised in inquiries regarding the nature of electric conduction. E. E. F.

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298. *Dielectric Conduction.* **W. Leick.** (Wied. Annalen, 66. 5. pp. 1107–1127, 1898.)—Guttapercha, paraffin, and sulphur in thin sheets show a higher conductivity than in thick sheets. It also varies with the current intensity, being higher in the case of stronger currents. This increase shows an after effect resembling hysteresis, since the resistances are smaller when the current is

gradually reduced than when it is first made up to the same amount. Guttapercha and paraffin show no trace of polarisation, but sulphur and collodion show it strongly. E. E. F.

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299. *Electro-Thermal Relations.* **E. Riecke.** (Wied. Annalen, 66. 3. pp. 353–389, and 4. pp. 545–581, 1898.)—The author traces the connections between thermal and electric conductivity on the basis of Weber's theory of moving ions. He obtains elaborate formulæ for the two conductivities and for the ionic velocities, which he utilises for the investigation of the Peltier and Thomson effects. He treats the occurrences at the surface separating two different metals on the assumption of a mutual diffusion of ions between them, and developes a complete theory of thermoelectricity, followed by an investigation of galvanomagnetic and thermomagnetic effects. Finally, he identifies the negative particles projected by a kathode and the supposed negative ions in the metals, and shows that they are the same in all metals. In canal rays, projected from an iron kathode, the mass of the projected particles is known to be about 56 times that of a hydrogen ion. Hence these particles are probably divalent iron ions, and if the canal rays consist of positive ions of the kathode metal, then the supposed mobile negative particles in the interior of all metals are probably nothing else but metallic ions. Zeeman's discovery leads to the assumption that the light of incandescent sodium vapour is produced by particles having a circular motion, of diameter $0·041 \times 10^{-6}$ mm. The diameter of Ampere's current round the iron molecule is about $3·86 \times 10^{-6}$ mm. E. E. F.

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300. *Pyroelectricity.* **W. Voigt.** (Wied. Annalen, 66. 5. pp. 1030–1060, 1898.)—The question is proposed as to whether the phenomena of pyroelectricity can be entirely reduced to those of piezoelectricity, by taking into account the changes of volume which invariably accompany changes of temperature. The author finds that about 80 per cent. of the pyroelectric charge is really piezoelectric in the case of tourmaline, but that the remainder of the charge is purely pyroelectric. The contrary result of the previous experiments made by Riecke and the author is explained by the fact that Pfaff's values for the thermal dilatation of tourmaline were not correct. On substituting correct values in the former experiments, the results are found to agree. As a general result, the author states that in crystals without a singular direction all pyroelectric charges may be reduced to piezoelectricity, but where some crystallographic direction is of a special character, there remains a residue which cannot be so explained. He proposes to restrict the term pyroelectricity to that charge produced by heating which would not be produced if

the body were kept at its original volume. A pressed tourmaline is a good source for a definite quantity of electricity. E. E. F.

301. *Intermediate Conductors.* **J. Stark.** (Wied. Annalen, 66. 2. pp. 245–268, 1898.)—The author investigates the problem of the distribution of current intensity at the surfaces of metallic conductors in electrolytes when traversed by a current. The fundamental case considered is that of a double plate of two metals, forming a closed circuit. The current is most intense at the edges, where the path from one plate to the other through the liquid is shortest. The positive element is eaten away most rapidly there. When a current is sent through the liquid, the intensities due to it and to the double plate are superimposed. When a single plate is used, it is converted, generally speaking, into a double plate by a metallic deposit from the electrodes upon the kathode side. The author gives an elegant graphic method of representing the current densities. E. E. F.

302. *Electrolytic Polarisation.* **H. Jahn.** Zeitschr. Phys. Chem. 26. pp. 385–429, 1898.)—The author measures the energy required to overcome the polarisation of an electrolytic cell by observing the fall in current from a battery of constant E.M.F. when the electrolytic cell is substituted for a non-polarisable cell of equal (negligible) resistance. The energy is calculated in heat units by Joule's formula, taking 0·2362 cal. as the equivalent of a watt-second. The battery, a modification of the Warren de la Rue element, placed in an ice-calorimeter, gave nearly constant values for the heat evolved in the same, per unit current, and afforded a check on the value of the E.M.F., and the calculated values for the potential of polarisation agreed within the same limits of accuracy (2–3 per cent.) with the values directly observed by Neumann and others. The temperature-coefficient is also calculated from observations at 0° and 40° C. The author also applies Planck's formula for the thermodynamical calculation of the polarisation, and comes to conclusions similar to those of Nernst and Le Blanc. B. B. T.

303. *Flame-electrodes and Dropping-electrodes.* **E. R. v. Schweidler.** (Wien. Akad. Sitzber. 107. pp. 225–233, 1898.) —It is of interest to know (1) how far the efficiency of a collector of this type is diminished by the imperfect insulation of the system (electroscope or electrometer) connected with it and the consequent leakage; and (2) what time is in practice required for the equalisation of potentials effected by the collector (which is

theoretically an asymptotic process of infinite duration). Pellat found that impregnated strips of paper worked very slowly, water-collectors better, and flames by far the best—almost instantaneously. Exner found, under given circumstances, that the charges collected by a water-collector, and a flame were in the ratios of 0·1 : 0·5 : 1. Lord Kelvin appears to prefer his water-collector even to flames, but gives no data suitable for direct comparison. The author has endeavoured by two methods to estimate the magnitude of the conduction-current produced by such collectors when there is a given difference of potential. (I.) A conductor of known capacity C is connected with an electrometer and the collector and gives to the whole insulated system a charge whose potential V is read off on the electrometer; if the collector is placed in a space of potential V_0, the discharge-current can be obtained from the change of V by the formula—

$$i = -C\frac{dV}{dt}$$

where dV/dt is a function of $(V-V_0)$. (II.) In the second method the collector is again placed in a space of potential V_0 and is connected through a galvanometer to a point of constant potential V_1; the current corresponding to the potential difference (V_1-V_0) is then measured directly.

A. *Measurements with Flame-electrodes.*—These were first made according to Method I., using an insulated Bunsen burner. On account of the electrification of the air in the room by the gases arising from the flame, it was found that the rate of discharge was not proportional to the difference of potential. The burner was therefore mounted on a plank and pushed out some 200 cm. through the open window: although it was provided with a metallic cylinder as a protection against the wind, its action was still very irregular. The approximate magnitude of the discharge-current was 10^{-11} ampere per volt. Measurements made by the second method (using a galvanometer of 10,000 ohms resistance) gave values lying between $1-3\times10^{-11}$ ampere per volt. Candle-flames gave about half the effect of a Bunsen burner.

B. *Measurements with Dropping-electrodes.*—The water-collector used was made by removing the bottom of a flask, which was then inverted and a cork and glass tube with drawn-out end inserted in its neck. The outflowing stream of water was surrounded by a brass cylinder 20 cm. high and 10 cm. in diameter, placed so that the point at which the stream broke up lay in the centre of the cylinder. Such a collector gave a current $i=2{\cdot}05\times10^{-11}$ ampere per volt, or had an apparent resistance of $r=\frac{1}{i}=4{\cdot}88\times10^{-10}$ ohms. The efficiency of water-collectors could probably be increased by using fine orifices and high pressures. D. E. J.

304. *Drop of Potential in the Electric Arc.* **Mrs. Ayrton.** (Electrician 41. p. 720, 1898.)—From the + carbon to the arc the drop $V=31{\cdot}28+\frac{9+3{\cdot}1l}{A}$ From the − carbon to the arc the drop $V'=7{\cdot}6+\frac{13{\cdot}6}{A}$. As the exploring carbon influences the length and voltage of the arc an insulated exploring pencil is being made. M. O'G.

305. *Magnetic Effect of Electrolytic Currents.* **S. Sheldon** and **G. M. Downing.** (Phys. Rev. 7. pp. 122–123, 1898.)—The authors investigate the magnetic field produced by an electrolytic current in order to determine whether a current passing through an electrolyte produces magnetic influences of the same magnitude as a current of equal strength passing through a metallic conductor under the same conditions. An iron anchor ring is wound with a copper secondary and a primary of rubber tubing containing 30 per cent. solution of sulphuric acid. Then the electrolytic primary is replaced by a copper-wire primary. Using identical ampere-turns practically equal throws were obtained. S. S.

306. *Batteries for Experimental Purposes.* (Elect. World, 31. p. 716, 1898.)—A short useful account of easily constructed primary and secondary batteries suitable for supplying current for laboratory purposes. W. R. C.

307. *Efficiency of Bichromate Cells.* **W. Gratz** and **H. C. Schwecke.** (Elect. World, 32. pp. 12–13, 1898.)—This paper is an abstract of a thesis presented to Lehigh University. Curves are given showing the efficiency of a Fuller and of a Grenet cell. The ratio of theoretical consumption of zinc to the actual consumption of course increases with the current. The number of watt hours per gramme of zinc reaches a maximum for a definite current. W. R. C.

308. *Electricity direct from Carbon.* **F. Foerster.** (Chem. News, 78. pp. 180–182, 191–192, and 206–207, 1898.)—The author gives a brief account of a number of cells intended for the direct production of electricity from carbon, or its compounds. W. R. C.

309. *Thermo-Electric Battery.* **C. J. Reed.** (Amer. Instit. Elect. Engin. 15. pp. 291–325, 1898.)—The author reproduces and discusses a number of results obtained by Liebenow and

Strasser with cells containing fused alkali as the electrolyte. He claims that these results support a thermo-electric theory and not a chemical theory as supposed by their authors. In the subsequent discussion **Steinmetz** contended that the E.M.F. might be directly due to chemical action owing to the variation of chemical affinity with temperature, although indirectly due to the external heat supplied. W. R. C.

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310. *Diffusion in the Action of Accumulators.* **L. Jumau.** (Écl. Électr. 16. pp. 413–416, 1898.)—The sulphuric acid in a lead accumulator exists partly in the depth of the active material, and partly in the electrolyte, from which it passes into the material by diffusion. The amount of diffusion is proportional to the surface exposed, to the difference of concentration, and to the time; hence the capacity varies with the porosity of the active material, the density of the liquid, and the intensity of the current. The amount of acid in the active material depends, however, on the nature of the charges and discharges previously undergone, and therefore the capacity should vary with this factor also. A series of experiments show that this is the case, especially with electrolytes of low density: on repeatedly charging and discharging an element made up of a positive plate between two negatives, the current plotted against the capacity gives a closed curve, showing definite hysteresis. J. W.

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311. *Induction-Coils.* **B. Walter.** (Wied. Annalen, 66. 4. pp. 623–635, 1898.)—In extension of the author's last communication, he quotes a value found for the capacity of the secondary coil. Although it only amounts to $1{\cdot}1 \times 10^{-12}$ farad, it produces a loss of energy which should be avoided by suitable winding and a good choice of a dielectric, so as to reduce the duration of the magnetic oscillations at the break of the primary circuit. The magnetic material should combine a high susceptibility with a small hysteresis. E. E. F.

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312. *Induction-Coils.* **W. Hess.** (Wied. Annalen, 66. 5. pp. 980–998, 1898.)—The oscillations in the secondary circuit of an induction-coil are studied by the aid of the Kerr effect. A liquid condenser containing carbon bisulphide is mounted between two crossed Nicols, and every discharge is accompanied by a brightening of the field illuminated by an arc lamp, owing to the Kerr effect in the carbon bisulphide. An additional improvement is added by inserting between the condenser and the second Nicol a compressed glass plate, which produces a field of bright and dark fringes. These fringes are displaced at every discharge. A cross section of the fringes is cut out by means of a slit and

photographed by means of Klinkert's pendulum apparatus just as the discharge takes place. This has the great advantage over the older pendulum methods that the whole phenomenon is recorded in its entirety, although it suffers under the disadvantage that the fringes are never very sharp, and the curves always a little blurred. The author reproduces plates showing some of the photographs obtained. They show multiple oscillations in circuits with high inductances, and simple displacements in circuits of high resistance. E. E. F.

313. *String Interrupter.* **L. Arons.** (Wied. Annalen, 66. 5. pp. 1177–1179, 1898.)—The author's new type of string interrupter does not require an electromagnet, and is therefore specially adapted to high oscillations which would be injuriously affected by high inductances in the circuit. A copper wire is stretched between two binding-screws joined by a conductor. In the centre of the wire is mounted a thin platinum wire which dips into mercury under water, and makes contact for a circuit. A horseshoe magnet is fixed above the wire, so that it attracts both portions of the wire when the current passes. The attraction interrupts the current and sets the wire vibrating in its own natural period. E. E. F.

314. *Temperature Coefficients of the Standards for the 1897 ohm.* **M. Solomon.** (Electrician, 41. pp. 717–719, 1898.)—Explains the thermostat used for varying the temperature of one standard 10-ohm coil while the other was kept constant. Four sources of error are considered. The tests are tabulated and Mr. Glazebrook's 1897 test confirmed. M. O'G.

315. *Absolute Electrometer.* **A. Perot** and **C. Fabry.** (Journ. de Physique, 7. pp. 317–335, 1898.)—The authors give an account of their absolute electrometer which has already received frequent notice (see Phys. Soc. Abstracts, No. 494, 1897, and Science Abstracts (1898) Nos. 23, 233, and 485). W. R. C.

316. *Exploring the Potential Round Commutators.* **G. D. Shepardson.** (Amer. Electn. 10. pp. 453–454, 1898.)—The author describes a simple and accurate device for exploring the potential round commutators which is in use in the electrical laboratory of the University of Minnesota. The device consists of a strip of hard fibre 1/16 inch thick, 1/4 or 3/8 inch wide, and long enough to reach a little more than half-way round the commutator. A row of small holes is drilled in the fibre at distances

apart each equal to the width of one commutator bar, together with the mica insulation. A larger hole is drilled at each end of the strip, into which a hard cord or wire is fastened. A thin coating of graphite is then smeared over the inside of the ring for purposes of lubrication. The strip is fixed on the commutator, and the potential round may be explored either by the single or double brush method, the end of the wire being held against the commutator through the holes. W. G. R.

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317. *Alternate-Current Problems.* **T. R. Lyle.** (Electrician, 41. pp. 816–818; 42. pp. 72–74 and 148–151, 1898.)—The author introduces symbols for the various operations by which, in the ordinary clock diagram methods, we pass from the current to the E.M.F. vector, and *vice versâ*. Thus, if C stand for the current vector in a clock diagram, E for the E.M.F. vector, and if R and L denote the resistance and inductance of the circuit respectively, the author writes the vector-equation

$$E = r\,C,$$

where r is an *operator*, and denotes the operation by which the current-vector is transformed into that of E.M.F. If i be now used to denote the operation of turning a given vector through a right angle ($i^2 = -1$), and $e^{i\phi}$ that of turning it through an angle ϕ in the positive direction, then, putting $I = \sqrt{R^2 + p^2 L^2}$, and $\tan\phi = Lp/R$, r may be variously written as

$$R + ipL, \text{ or } I\,(\cos\phi + i\sin\phi), \text{ or } I\,e^{i\phi}$$

Further, if we write $\frac{1}{r}\,E = C$, $\frac{1}{r}$ may be shown to be correctly represented by

$$\frac{1}{R + ipL}, \text{ or } \frac{R - ipL}{I^2}, \text{ or } \frac{\cos\phi - i\sin\phi}{I}, \text{ or } \frac{e^{-i\phi}}{I}.$$

The operator r follows the ordinary laws of algebra, and it is at once evident that by its use the vector equations connecting the various vectors in a clock diagram are considerably simplified. The author applies this elegant notation to the solution of a number of problems, by which the simplicity and power of the method are strikingly exemplified. A. H.

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318. *Energy of the Magnetic Field.* **H. Pellat.** (Comptes Rendus, 127. pp. 507–510, 1898.)—This refers to a former paper by the same writer (C. R. 125. p. 699, 1897), in which he showed that the ordinary expression for the energy of an electric system

requires to be rectified by taking account of the heat withdrawn or introduced during the charge. In the present paper the same thing is shown for a magnetic system. A system of closed currents is supposed to increase in intensity from zero to I_1 I_2. The current in the first circuit at any instant is $\frac{i_1}{I_1}=z$; in the second $\frac{i_2}{I_2}=z$, &c. If dQ be the quantity of heat supplied from without, during the increase dz of z, it is assumed that

$$dQ=cdT+bdz$$

where T is absolute temperature. And it is shown that b is not zero. S. H. B.

319. *Mechanical Illustration of Magnetic Phenomena.* **C. Weyher.** (Comptes Rendus, 127. pp. 811–813, 1898.)—A magnet is represented by a wooden cylinder provided with oblique vanes, and capable of being set in rotation. It is suspended in such a manner that while rotating it is capable of being deflected like a pendulum. When rotating, it sucks in air (or water, if placed in a vessel containing that liquid) at either end, and ejects it at the middle. If two such cylinders be set rotating, the phenomena of magnetic attraction and repulsion may be reproduced. A. H.

320. *Magnetic Properties of Nickel Steels.* **E. Dumont.** (Écl. Électr. 16. pp. 292–300, 1898.)—An account of investigations supplementing those of Guillaume, already noticed in Abstract No. 1257 (1898). J. J. S.

321. *Deformation of Iron in a Magnetic Field.* **E. Rhoads.** (Phys. Rev. 7. pp. 65–82, 1898.)—Strips of iron are cut from a sheet of transformer iron, some at right angles, others parallel to the length. The latter show greater elongations in a magnetic field, and indicate that the elongations in a given direction are influenced by the fibrous structure. A. Gs.

322. *Magnetisation by Alternate Currents.* **M. Wien.** (Wied. Annalen, 66. 5. pp. 859–953, 1898.)—Small toroids were made of thin iron wire, and provided with a magnetising coil. Their inductance and effective resistance were determined after Maxwell's method by the optical telephone. The magnetising current was provided by an alternate-current siren, and

had frequencies of 128, 256, or 520 per second. It was made very approximately sinusoidal by resonance. It was found that these currents not only produce an induction of the same period, but also of higher periods, the latter becoming more marked as saturation is approached. The loss of energy is enhanced by these higher periods and by the heat generated by them. It is found that separate insulation of the constituents of the core is ineffective as a remedy. Permeability and induction are always smaller in the sinusoidal than in the constant field, but the difference is small in the neighbourhood of the saturation point. It is larger, on the other hand, when the frequency is high and the iron wire is soft and thick. As a general result, it appears that induction cannot keep up with very rapid oscillations of the magnetising force. In such fields iron behaves as if it were harder than it is in a constant field. The hysteresis loops are broader and shorter. E. E. F.

323. *Magnetisation of Crystals.* **A. Lutteroth.** (Wied. Annalen, 66. 5. pp. 1081–1106, 1898.)—A large number of hydrated sulphates and alums were examined by Wiedemann's method. They belonged to the monoclinic and rhombic systems, and some were paramagnetic and others diamagnetic. In all of them the ratio of the magnetisations along any two axes changed with the temperature in a linear manner. In any group of crystals belonging to the same isomorphous series the temperature coefficients along the three axes are in a constant proportion. For the sulphates of nickel, zinc, and cobalt the temperature coefficient is positive when the axis of greatest magnetisation is made the axis of suspension, but negative when the intermediate axis of magnetisation is chosen. This result is opposed to that of Faraday. The author also shows that the orientation of a crystal in a homogeneous magnetic field may be fully explained on the assumption of molecular magnets capable of turning. E. E. F.

324. *Magnetic Susceptibilities.* **J. Koenigsberger.** (Wied. Annalen, 66. 4. pp. 698–734, 1898.)—The author has confirmed H. du Bois's theorem according to which the susceptibility of ferric chloride and other solutions is constant in various fields, so long as they contain no free iron. He finds that bodies with the smallest atomic volume are, generally speaking, the most strongly paramagnetic. The susceptibility of water is found consistently to be $-0{\cdot}8\times10^{-6}$ at 20° in air. E. E. F.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

325. *Etherion—a New Gas.* **C. F. Brush.** (Science, 8. pp. 485–494, 1898.)—The author from the high heat conducting capacity of high vacua believes that an occluded gas of insignificant molecular weight but of very high specific heat and molecular velocity exists in glass and other solids. Alterations in pressure were noticed when phosphorus pentoxide and soda-lime were present in the vacua; the author concluding that the gas is reabsorbed by them. (See also Phil. Mag. Jan. 1898.)
S. R.

326. *Process of Crystallisation.* **G. Tammann.** (Wied. Annalen, 66. 3. pp. 473–498, 1898.)—The current opinion which assumes the possibility of a continuous transition from the liquid to the crystallised state and *vice versâ* is, according to the author, inconsistent with theory and with actual observations. The only satisfactory definition of the solid state rests upon the assumption of a discontinuity between the solid and liquid states. Ostwald supposes that the crystallisation curve may proceed along a Thomson-van-der-Waals isothermal. But this assumption implies the existence of four volumes at the same pressure. Heydweiller's observation of an alleged continuous transition of menthol from the liquid to the crystallised state, with formation of a peculiarly transparent variety of the crystals, is probably due to some impurity in the menthol used.
E. E. F.

327. *Gelatinisation of Starch.* **H. Rodewald.** (Zeitschr. Phys Chem. 24. pp. 193–218, 1897.)—By determining the heat evolved when water is added to starch, the author finds that the heat of gelatinisation is a function of the amount of water absorbed. The alteration in volume is similarly a function of the water content. He shows that the specific volume of starch $X_0=0{\cdot}67273$ and gives tables showing the volume contraction with varying amounts of water. From the vapour pressure changes he calculates the molecular weight of gelatinised starch as 4374 or $(C_6H_{10}O_5)_{27}$. He also shows that the coefficient of expansion is a function of the water content.
S. R.

328. *Conductivity of Solutions of Praseodymium and Neodymium Sulphates.* **H. C. Jones and H. M. Reese.** (Chem. News, 78. pp. 102–103, 1898.)—The following numbers are obtained;

v is the volume of solution in litres, containing 1 gram molecule of the salt, and μ the molecular conductivity :—

Praseodymium Sulphate (Mol. weight = 569·1).		Neodymium Sulphate (Mol. weight = 575·4).	
v.	μ.	v.	μ.
14·71	98·33	...	...
29·42	117·43	25·33	115·03
58·84	141·42	50·65	137·65
117·68	169·47	101·31	166·35
294·2	217·83	202·61	197·91
588·4	262·65	506·5	255·43
1176·8	317·10	1013·0	303·45
1471·0	331·43	2026·0	366·0
2942·0	403·37	2532·6	382·9
5884·0	482·61	5065·2	462·5

The units and temperature employed are not stated. (Cf. American Chem. Journ. 20. p. 345.) T. E.

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329. *Electrolytic Solution of Noble Metals.* **M. Margules.** (Wied. Annalen, 66. 3. pp. 540–543, 1898.)—The author describes a simplified apparatus for the electric solution of gold and platinum. A revolving commutator alternately sends the current through the cell, and short-circuits it. Another device consists of a hammer interrupter, to which a separate contact piece is attached. At every oscillation, the contact piece short-circuits the cell, or sends a current through it in opposition to the first current. Under these circumstances, platinum dissolves at the electrode, which is the anode for the stronger current or the greater electric quantity. The behaviour of gold is very different from that of platinum. The latter cannot be dissolved even in hydrochloric acid by means of a constant current, whereas gold is easily dissolved in hydrochloric, strong nitric, or sulphuric acid, under the influence of a constant current. E. E. F.

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330. *Calculation of Electrolytic Conductivity.* **F. C. McKay.** (Elektrochem. Ztschr. 5. pp. 113–119, 1898.)—An elaborate series of measurements of the conductivities of barium and sodium chlorides made by Kohlrausch's method, with special precautions as to purity and accuracy of analysis, show that MacGregor's graphic method of calculating the conductivity of a mixed solution is valid in this case up to a concentration of 2 gram-mols. per litre. J. W.

331. *Mobility of Ions.* **F. Kohlrausch.** (Wied. Annalen, 66. 5. pp. 785–825, 1898.)—The author attempts to find some rule and tables by which the conductivity of a solution of one or more salts can be found from a knowledge of the mobilities of their ions and their respective concentrations. He finds that for solutions up to deci-normal strength such tables of mobilities can be found, and that as long as the ions are monovalent, or only one combination is divalent, the conductivities of any solutions containing one or two salts can be calculated. An important observation made is that the same ion possesses the same mobility in different electrolytes; also, the decrease of mobility with increasing concentration is approximately the same for all ions. The mobilities at infinite dilution are:—

Kations: K 65·3, Na 44·4, Li 35·5, Rb 67·3, NH_4 64·2, Ag 55·7, and H 318.

Anions: Cl 65·9, I 66·7, F 46·1, NO_3 60·8, ClO_3 55·3, $C_2H_3O_2$ 34·5, HO 174.

The decrease of mobility from these values at infinite dilution to the values at any given concentration is directly proportional to the linear concentration, *i.e.*, the cube root of the volume concentration. The much more mobile ions H and HO show a much stronger decrease of mobility. So do the combinations of divalent ions when mixed with monovalent salts.

E. E. F.

332. *Alleged Decomposition of Sulphur (Bythium).* **H. Alexander.** (Zeitschr. Elektrochem. 5. pp. 93–95, 1898.)—The alleged new element *bythium*, stated by Gross to result from the decomposition of sulphur in the electrolysis of a fused mixture of silver chloride and sulphide, is non-existent, as the product of the electrolysis is proved by elaborate chemical analysis to contain the same elements, and in the same quantity, as the original subtances. J. W.

333. *Electrolytic Preparation of β-Phenylhydroxylamine.* **F. Haber.** (Zeitschr. Elektrochem. 5. pp. 77–78, 1898.)—Describes a special form of cell for the electrolytic reduction of this substance from nitrobenzene. Orthotolylhydroxylamine is prepared in the same way from orthonitrotoluene. J. W.

334. *Electrolytic Formation of Azo- and Hydrazo-Compounds.* **K. Elbs** and **O. Kopp.** (Zeitschr. Elektrochem. 5. pp. 108–113, 1898.)—Various nitro-compounds are electrolysed in presence of sodium acetate, in dilute alcoholic solution, and the products examined and identified. Mainly of chemical interest.

J. W.

335. *Electrolytic Production of Beryllium and its Alloys.* **P. Lebeau.** (Elektrochem. Ztschr. 5. pp. 111–113, 1898.)—The simple halogen salts of beryllium are non-conductors, but the double alkali fluorides, such as beryllium potassium fluoride, readily melt to conducting liquids which yield beryllium on electrolysis. The kathode is a nickel crucible, the anode a carbon rod; the current is 20 amperes at 80 volts, and the metal is deposited in brilliant hexagonal crystals of sp. gr. 1·73, containing 99·7 per cent. of beryllium. Alloys are prepared electrolytically by substituting for the nickel crucible the desired metal melted in a hollow carbon kathode; they are also formed by reducing the mixed oxides of beryllium and the metal with carbon in an electric furnace carrying 900 amperes at 45 volts. The appearance of copper is quite changed by 0·5 per cent. beryllium, and with 21·3 per cent. the alloy is golden yellow, and very sonorous.

J. W.

336. *Electrolytic Reduction of m-Nitro-p-toluidine.* **K. Elbs** and **B. Schwarz.** (Zeitschr. Elektrochem. 5. pp. 113–115, 1898.)—An account, from a chemical point of view, of the products of electrolysis of solutions of the above substance.

J. W.

337. *Electrolytic Production of Metallic Oxides.* **Otto** and **H. Strecker.** (Electrician, 41. pp. 17–18, 1898.)—The economical production of metallic oxides by electrolysis depends on a proper choice of electrodes and on the composition and density of the electrolyte. The E.M.F. required may often be reduced by using as the kathode a metal other than that which forms the anode. Tables are given showing the requisite E.M.F. for any pair of metals, when a solution of sodium chloride (26 per cent.) or of sodium chlorate (15 per cent.) is used as the electrolyte. When the latter consists of a solution of two salts, one of which acts as a solvent and the other as a precipitant, the former should be present in such a proportion as to yield a solution of maximum conductivity, whilst the quantity of the latter to be employed is calculated according to the electro-chemical equivalents and the reaction which it is desired to effect. N. L.

338. *Electrolytic Determination of Uranium and Cadmium.* **E. F. Smith** and **D. L. Wallace.** (Chem. News, 78. p. 58, 1898.)—Heidenreich has used the authors' methods for the electrolytic determination of the above metals, and has failed to obtain satisfactory results. In order to confirm their earlier results, the authors have repeated their experiments, and give figures to show that under the conditions recommended their

methods are entirely satisfactory. For uranium they use a solution of the acetate, and for cadmium they employ a solution containing sodium phosphate and free phosphoric acid. The article gives details of the experiments, and the results of three determinations of known amounts of each of the metals.

J. B. C. K.

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339. *Deposition of Cadmium and its Alloys.* **S. Cowper-Coles.** (Elect. Rev. 43. pp. 587–588, 1898.)—An article giving details of the solutions recommended by Smee, Woolrich and Russell, and Bertrand, for obtaining deposits of metallic cadmium. Details are also given of the method to be used for obtaining deposits of cadmium-silver alloys. These are stated to be coming into use for plating parts of bicycles and domestic articles. A cyanide solution of the two metals is recommended, containing 3–4 oz. metal in solution per gallon, and from 8 to 25 dwts. silver per gallon. A low current density must be employed. If stronger solutions be used, the proportion of silver in the deposited alloy will be increased. Trials have shown that this alloy is superior to nickel as a coating for iron exposed to atmospheric influences.

J. B. C. K.

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340. *Deposition of Chromium.* **S. Cowper-Coles.** (Elect. Rev. 43. pp. 477–478, 1898.)—The author describes some of the characteristics of chromium, and then goes on to describe Professor Hittorf's experiments on the behaviour of chromium in dilute acid solutions. A brief description is also given of Herr Eskmann's process for preparing chromium in the electric furnace.

The production of chromium by reducing chromium oxide with aluminium in a fine state of division is mentioned; the paper concludes by giving the price of chromium and its salts, and a brief description of some experiments made with the electro-deposition of chromium, and a table is given of the comparative hardness of electro-deposited chromium as compared with other metals.

AUTHOR.

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341. *Electrolysis of Alkali-metal Chlorides.* **H. Wohlwill.** (Zeitschr. Elektrochem. 5. pp. 52–76, 1898.)—A detailed account of an investigation carried out by the author, too lengthy for full abstraction. The object of the author was to discover whether the formation of hypochlorites and of chlorates during the electrolysis of aqueous solution of sodium or potassium chloride, was due, as generally supposed, to secondary chemical reactions, or as some of the latest investigations had indicated, to primary electrolytic, or "ionic," reactions. He discusses the published literature of the subject, and refers to the previous work of Nernst and

Glaser, of Oettel, and of Haber, in relation to this subject. After describing his method of investigation and the apparatus used, he gives a detailed account of the results obtained in the numerous electrolytic decompositions of chloride solutions with gradually increasing E.M.F. at the cell electrodes, the results being given in numerous "curve" diagrams.

The whole investigation led him to the following conclusions:—

(1) A formation of hypochlorite occurs, when an E.M.F. of only 1·2 volts is attained, between a platinum anode and hydrogen kathode. The formation is practically quantitative, and is probably represented by the following ionic equation:—

$$\overline{\mathrm{Cl}}+\bar{\bar{\mathrm{O}}}\ (+\ \ +)=\overline{\mathrm{ClO}}$$

(2) A formation of hypochlorite in much larger quantity occurs when the E.M.F. rises to 2·1 volts or above this limit. This is attributed by the author to the secondary chemical reaction of the separated chlorine with the alkali formed at the kathode.

(3) The formation of chlorate is explained by the author as due to the + charges of electricity, communicated to the ions at the anode. The ionic reaction is, however, not between $\overline{\mathrm{Cl}}$ and $\overline{\mathrm{OH}}$ ions, but between previously formed $\overline{\mathrm{ClO}}$, and $\overline{\mathrm{OH}}$ ions, and is probably represented by the following equation:—

$$2\ \overline{\mathrm{ClO}}+\overline{\mathrm{OH}}\,(+\ +)=\mathrm{H\,ClO_3}+\overline{\mathrm{Cl}}$$

J. B. C. K.

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342. *Electrolytic Galvanising.* **S. Cowper-Coles.** (Elect. Engin. 22. pp. 466–467, 1898.)—This is an abstract of a paper read before the Society of Engineers. The first part of the paper, dealing with the causes of corrosion and the old method of hot galvanising, are passed over in a few words, but the portion which deals with the question of the best solutions from which to obtain coherent bright zinc deposits upon iron and steel, is given verbatim. The author describes and comments on Elsner's, on Siemens and Halske's and on other methods. He also refers to Kiliani's researches into the importance of considering the E.M.F. and current density for obtaining firm deposits. A total analysis of a typical sample of spongy zinc is given, which may be of use. J. L. F. V.

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343. *St. Michael Electrolytic Chlorate Works.* **J. B. C. Kershaw.** (Elect. Rev. 43. p. 791, 1898.)—The author describes important developments which have taken place since 1890 in the South-Eastern Provinces of France (Rhone valley) in the utilisation of water power for electrochemical processes. Over 10,000 H.P. are already available. An account of the installa-

tion at St. Michael below Modane on the Arc, a tributary of the Rhone, is here given. At the works of the Société d'Electrochimie 3000–4000 H.P. are utilised for the manufacture of sodium and potassium-chlorate by the Gall and Montlaur process. An underground channel 1½ miles in length conveys the water 230 feet above the works and operates twelve 200-H.P. and four 400-H.P. turbines from two pipe lines 330 yards long, 47" diameter, capable of delivering 1,760 gallons water per second. Thury dynamos running at 300 revs. generating a current of 1000 or 500 amperes at 200 volts, or 2000 kw. in all, are used. The principle for the production of chlorates is that already patented by C. Watt in 1837, *i.e.*, the electrolysis of an alkaline chloride between insoluble anodes at a moderately high temperature. A series of equations are given explaining reactions involved. In practice, rectangular lead-lined vats of 11,000 gallons capacity are used, fitted with anodes of a platinum-iridium alloy and kathodes of ferro-nickel, the latter being covered by asbestos cloth in order to remove the hydrogen generated at the surface. Diaphragms were originally used, but are believed to have been abandoned. A current density of 465 amperes is employed, and the solution thereby kept at a temperature of 45° C., no external heat being required. The chlorate is separated by crystallisation and the solution brought up to strength by the addition of fresh chloride. The presence of metallic oxides in the vat acts deleteriously, resulting in the formation KCl and O from $KClO$. The Société d'Electrochimie possess another works at Vallorbes with 3000 H.P. The total output of the two works amounts to about 1800 tons per annum. The author gives particulars as to cost of production, and concludes that there is not a large margin of profit. O. J. S.

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344. *Dumoulin Copper-Depositing Process.* **J. B. C. Kershaw.** (Elect. Rev. 43. pp. 561–562, 1898.)—An illustrated description of the writer's visit to the works of the Electrical Copper Company at Widnes. The company owns the Dumoulin Patents. The plant comprises 5 Peach Engines, each of 160 I.H.P., direct coupled to 5 Crompton continuous current dynamos. These deliver 1300 amperes at 75 volts = 97·5 kw. each. The depositing vats are 30 in number, and are shallow lead-lined troughs, each provided with a revolving mandrel 12 ft. long × 16" in diameter. This mandrel is half immersed in the electrolyte, and functions as kathode. The electrolyte contains 7 per cent. free acid, and 40 per cent. copper sulphate, and is cooled and filtered after each passage through the depositing vats. The deposit of copper upon the mandrel is rendered coherent and dense by means of strips of sheepskin, which hang over, and lightly press upon, the upper surface of the mandrel. Thick plates of raw copper, bent into semicircular form, are used as anodes. Under normal working conditions 10 hours suffice to

deposit 44 lb. copper upon one mandrel, and to produce a tube of deposited copper, weighing 14 oz. to the sq. foot. The current density employed varies between 35 and 40 amperes per sq. foot; and the E.M.F. required is 1·6 volts at first, rising as the anodes become eaten away. The large tubes of copper made at Widnes are cut longitudinally, and converted into sheets having a superficial area of 48 sq. feet. The present capacity of the plant is equal to 60 sheets per day, but it is about to be increased by the erection of depositing vats for the production of boiler-tubes. Recent tests of the deposited copper show a tensile strength of 18½–24 tons, and an elongation of 28–30 per cent. AUTHOR.

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345. *Cowper-Coles Process for Treatment of Refractory Ores.* (Elect. Rev. 43. pp. 788–789, 1898.)—An illustrated description of this process as carried out at Hayle, in Cornwall. The ore is crushed, roasted, and leached in rectangular vats with a sulphuric acid solution—in order to extract the zinc. The vats hold from 1½–2 tons of ore; the finer portions of the ore are leached separately in a revolving barrel. The zinc is electro-deposited from the resultant zinc sulphate solution as zinc sponge upon a revolving disc kathode.

It is proposed to use this product in place of zinc dust. It contains 54·8 per cent. zinc, 12·55 per cent. combined oxygen, 10·55 per cent. sulphuric anhydride, 13·35 per cent. moisture and organic matter, 1·05 per cent. silica, 1·20 per cent. alumina, and smaller amounts of other impurities. The lead is extracted from the ore remaining in the leaching vats by a solution of sodium hydrate. The resultant sodium plumbate solution is either used in the electro-depositing vats, or is employed for production of white lead. In the former case, the revolving disc kathodes are used as before, to receive the deposit. Silver, if present, is extracted from the ore by dilute cyanide solution, and is recovered by electro-deposition upon silver kathodes. No details of efficiency or cost are given in the article. J. B. C. K.

GENERAL ELECTRICAL ENGINEERING.

346. *Preventing Magnetic Leakage from Dynamos.* **J. F. Kelly.** (Elect. World, 32. p. 161, 1898.)—This device forms the subject matter of U.S. patent No. 608133, and consists in arranging an electromagnet coil on the shaft connecting the crank-shaft of a direct-coupled engine to the inductor of the alternator driven thereby. This coil produces a magneto-motive force in the shaft which prevents a stray field being set up in the engine, this stray field being liable to cause binding and heating.
C. K. F.

347. *Detecting Approach of Objects at Sea.* **H. Herberts.** (Elect. Engin. N.Y., 26. pp. 97–99, 1898.)—This proposed apparatus comprises two thermopiles arranged on a ship and caused to slowly rotate about a vertical axis. These thermopiles are arranged with their collecting cones facing opposite sides, and are each connected through sliding contacts with a d'Arsonval galvanometer; the moving coils of these galvanometers bear aluminium arms which, when the coil is deflected, complete one or other of two electric-bell circuits, according to the direction in which the current flows, that is to say, when the thermopile cone is directed towards a warm body, a vessel for example, one bell will give a short ring, whilst when it is directed towards a cold object, an iceberg for example, the other bell will give a short ring. The direction of the particular object is determined by means of an electrically operated pointer which rotates synchronously with the thermopiles. By watching the instantaneous position of the revolving pointer at the moment the bell rings, and simultaneously cutting out one of the thermopiles by a switch, an approximate knowledge of the direction of the object can be obtained. By introducing resistance into the thermopile circuits, the aluminium arm can be made to complete the bell-circuit only at the instant the maximum current is being produced, and thus the exact direction determined. By the increasing or diminishing action of the thermopiles, it can be determined whether the object is approaching or receding. Further details and diagrams of the apparatus and modifications thereof are given in the original paper.
C. K. F.

348. *Westinghouse Electric Turn-table "Donkey."* (Elect. Engin. N.Y., 26. p. 185, 1898.)—This round-house "donkey" comprises a series reversible 10 H.P. motor mounted within a heavy cast-iron frame having a traction wheel which rests upon the rail of the turn-table pit and to which the power is transmitted through double reduction gears. The donkey-frame is con-

nected by drawbar and pin to one end of the turn-table at the side, sufficient traction for the driving-wheel being secured by the weight of the machine, 3,700 pounds. It may be moved in either direction, and its speed varied by means of a switch and rheostat controlled by a single lever. No changes are required in the turn-table in order to instal the "donkey." With turn-table light the donkey will make a complete revolution in 30 secs., whilst with a 10-wheel locomotive and tender, weighing 100 tons, a complete revolution is made in 45 secs. From actual tests it is stated that the power consumed is the equivalent of one-half H.P. hour. Assuming 6 pounds of coal per H.P. hour, with coal at $2 per ton, the cost of turning each locomotive would be 3/10 cent. C. K. F.

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349. *Boiler-Feeding by Injectors.* **J. Whitcher.** (Elect. Rev. 43. pp. 303–304, 1898.)—The author discusses boiler feeding by injectors and pumps. If a boiler at 140 lbs. working pressure be fed by a pump of 50 per cent. efficiency through a heater raising the temperature of the feed from 100° to 200° F., 1 lb. of steam will pump 100 lbs. of water, and the heat thrown away in the pump exhaust is 1,120 B.T.U., whereas the heat abstracted from the exhaust heater is 10,000 B.T.U. An injector will save the former quantity and reject the latter. Therefore it is bad policy to use an injector where feed heating is possible, and bad policy to use a pump unless in conjunction with a feed heater. Apart from the question of feed heating, the injector merits preference above all other appliances for boiler feeding. Better opinions regarding it would be obtained if two injectors of equal size and combined capacity, just slightly greater than the maximum rate of feed were mounted independently, so that either could be easily dismantled during working hours. A. S.

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350. *Mechanical Draft.* **W. B. Snow.** (Amer. Electn. 10. pp. 244–249, 1898.)—A paper discussing the advantages of mechanical draft from the points of view of increased boiler efficiency, possibility of increasing the power of boilers, and reduction of capital and working expenses. The paper is illustrated by numerous diagrams and examples from practice. A. S.

GENERATORS, MOTORS, AND TRANSFORMERS.

351. *Modern Brush-Holders.* (Elect. World, 32. pp. 87–91, 1898.)—The paper contains an interesting and fully illustrated description of the typical forms of brush-holders used in connection with the machines exhibited at the recent New York Electrical Show. Carbon brushes are used in every case, and in most holders are arranged to bear on the commutator in a radial direction (the tangent contact brush seems to have quite disappeared). It is impossible to adequately abstract the paper without a large number of sketches.

[An illustrated abstract appeared in *The Electrician*, 41. pp. 616–618, 1898.] A. H.

352. *Drum Armature Windings.* **A. L. Rice.** (Amer. Electn. 10. pp. 363–365 and 419–420, 1898.)—The author discusses the winding of slotted multipolar drum armatures with two or four layers, with either single wire or cable. In a four-pole armature with four layers, one conductor from each layer must be wound into a coil, the pitch must be odd, and the front and back pitch different. The whole of the bottom layer is wound first, then the whole of the next layer, and so on. In order to wind a four-layer armature into a two-circuit machine it is necessary to use a combination of lap and wave winding, which has been called Wenström winding; it follows no expressible law, but must be worked out for each case. R. B. R.

353. *Commutator Segments.* **F. X. Cicott.** (Railway World, 7. pp. 81–84, 1898.)—The author draws attention to the disadvantages of cast copper segments, and describes the process of drop-forging commutator segments. A cylindrical rod of copper of the size bar required is heated to a malleable state in an oil furnace producing a uniform heat, and while in that state the rod is bent to form, then passed for the action of dies in the drop-press and stamped, which produces an unfinished segment of the designed shape. This is treated with acid to remove the oxide. The rough edges are trimmed, and the bars cold-dropped to bring them to the required gauge. Hard drawn copper segments are also used in America. The General Electric Co. of Schenectady use hard-drawn only. The paper contains a table of angles of segments for commutators of 4 to 150 parts. The author concludes by remarking that the use of wrought copper should be seriously considered by the European manufacturers. R. B. R.

354. *Armature Winding for Multiphase Generators.* (Elekt. Runds, 15. pp. 264–265, 1898.)—The new method of winding used by the Maschinenfabrik Oerlikon for multiphase work is diagrammatically illustrated. It has the advantage of giving a symmetrical curve of E.M.F. without involving the use of two sizes of spool. E. H. C.-H.

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355. *Induction Motors.* **A. E. Wiener.** (Amer. Electn. 10. pp. 372–373, 1898.)—This is the third of a series of articles, and deals exclusively with the stator windings of di-phase and tri-phrase induction motors, both drum and ring windings being considered. W. G. R.

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356. *Rotary Converters.* **P. Janet.** (Comptes Rendus, 127. pp. 351–352, 1898.)—The author examines the working of a single-phase rotary converter on the assumption of 100 per cent. efficiency, and gives the following results :—

1. For a given excitation there exists only one alternating pressure E_a for which the pressure E_c on the continuous current side is given by $E_c = \sqrt{2}\, E_a$.

2. If without altering the excitation, E_a is varied, the ratio $\sqrt{2}$ no longer holds between the two pressures. The pressure E_c is then of an undulating nature and is compounded of a uniform pressure c and an alternating one having twice the frequency of the applied pressure.

3. If the applied alternating potential difference is kept constant while the excitation is varied, the pressure at the direct current side is undulating. If the excitation increases, the uniform pressure c increases but always remains less than E_c. W. G. R.

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357. *Transformer Regulation.* **F. Bedell.** (Elect. World, 32. pp. 364–365, 1898.)—The author gives working formulæ for determining the regulation drop in lighting and power transformers.

The secondary load in lighting transformers is non-inductive, and the effective reactance drop is

$$\frac{x^2 + 2\,x\,i_\mu}{200}$$

where x is the per cent. reactance drop and i_μ the per cent exciting current, magnetising component. The secondary load in power transformers is inductive, and the drop is now

$$c \cos \delta + x \sin \delta$$

where c is the per cent. resistance and $\cos \delta$ the power factor.

W. G. R.

POWER DISTRIBUTION, TRACTION, AND LIGHTING.

358. *Cost of Steam and Water Power.* **W. O. Webber.** (Eng. Mag. 15. pp. 922–927, 1898.)—The author estimates the present cost of operating a 1,000 H.P. steam plant as follows:—

	Dollars per H.P. per annum.
Interest on capital, depreciation, repairs, &c.	6·55
Coal (1·4 lbs. per I.H.P. hour, at 3·85 dols. per ton)	7·41
Wages (two engineers, two stokers)	3·08
Oil, waste, &c.	·80
Total	17·84

i.e., £3 14s. 4d. per H.P. per annum.

The actual return from the best plant known to the author gives a total cost of 11·64 dollars per H.P. per annum, the coal costing 1·76 dollars per ton. The plant consists of a vertical, cross-compound, condensing engine by the E. P. Allis Company, the load averaging 1,950 H.P. The steam pressure is 155 lbs. per square inch. The boilers are of the Heine water-tube pattern; an exhaust steam heater and a Green economiser are used.

The actual cost of a small water-power plant consisting of three wheels giving a maximum of 510 H.P. is 5·56 dollars (£1 3s. 3d.) per H.P. per annum, the average power being taken at 315 H.P.

A. S.

359. *Electrical Transmission of Power.* **P. Janet.** (Écl. Électr. 16. pp. 547–551, 1898; also Rev. gen. des Sciences pures et appliqués, 9. pp. 638–646, 1898.)—This paper gives several rules to be used in designing a transmission plant, and a careful analysis of comparative costs of several water and steam-power installations.

M. G. W.

360. *Unequal Loading in Polyphase Distribution.* **V. Spagnuolo.** (N. Cimento, 7. pp. 293–319, 1898.)—This paper treats of the variations in pressure produced in three-phase distribution when the loads on the three circuits are unequal, in respect to resistance, self-induction, or capacity. The star system only is considered, the variations in pressure being determined between each pair of the three conductors, and also between each conductor and a central neutral wire. The matter is treated theoretically at great length, and the results of some experiments are given, made on a Gramme continuous current machine adapted for three-phase currents. The load was varied by introducing resistance or self-induction. The following conclusions are arrived at: If

1, 2, 3 be the three circuits taken in the sense of the rotating field, and V_1 V_2 V_3 the respective pressures, if the resistance in 2 be increased, V_2 is largest, V_1 is smallest, and V_3 slightly more than V_1. The same effects are produced in the difference of potential between each conductor and the neutral wire, but the variations are less marked. With equal resistances, if self-induction be introduced in 2, V_2 is largest, V_3 is smallest, and V_1 slightly more than V_3. Considering the pressures to the neutral wire, V_3 is smallest, and V_1 and V_2 are equal. G. H. BA.

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361. *Llandudno Electric Supply Works.* (Electrician, 42. pp. 11–14, 1898.)—The paper contains a full description of the works, the principal feature of interest being the arrangement for firing two of the boilers from Beaman and Dea's refuse destructors. M. G. W.

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362. *Boston Electric Lighting Station.* (Elect. World, 32. pp. 523–527, 1898.)—This is a good account of the Boston Electric Light Station which has from an early commencement been conducted on alternating current lines, and well illustrates the advantage of using synchronous motors. There are no less than twenty 150 kilowatt synchronous motors each coupled to two 160-light Brush multicircuit arc machines. The switchboard is remarkable for the use of aluminium bus bars, mounted on a separate marble board. W. G. R.

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363. *Three-Phase Installation at the Bristol Waggon and Carriage Works.* **W. Geipel.** (Elect. Rev. 43. pp. 427–429, 1898.)—This is a paper read before the British Association, and deals principally with the saving of power effected by using electric motors for driving machines instead of a multiplicity of steam engines in a works of wide area. At the Bristol Waggon Works five Lancashire boilers have been necessary for driving the engines; with electric power plant one Lancashire boiler will suffice, and the saving of coal is estimated at 37 tons per week. The three-phase system has been adopted for the electric plant for the following reasons:—

1. Absence of commutators on both generator and motors.
2. The more mechanical design and construction of the generator and motors, the windings of the latter, being entirely enclosed by the iron frame of the machine, protecting them from accidental damage.
3. The fact that the three-phase motors can be left running for long periods without any attention, which is not advisable in the case of direct-current motors.
4. The freedom from possibility of breakdown as compared with the direct-current system. W. G. R.

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364. *Glasgow Electric Tramways.* (Electrician, 42. pp. 104–109, 1898.)—Two and half miles of track between Glasgow and Springburn have been experimentally equipped with trolley system; 100-lb. rails, rolled in 45 ft. lengths by the Barrow Steel Co., are bonded with Daniel bonds. The poles, overhead equipment and cars were all made in Great Britain. Where centre poles are used, the trolley wire is carried on fiddle-string supports, which give an easier passage to the trolley wheel than the ordinary rigid American support. Section boxes at every half-mile connect through switches to the feeders, and also contain lighting arresters and telephones. Each of the 25 cars (mostly single decked) has two 55-H.P. motors of the usual American pattern. Important experiments on electric brakes are in progress. The power station is independent from the lighting station and contains Babcock boilers, Vicar's coking stokers, McIntosh and Seymour engines and Westinghouse generators rated at 200 kw., also a standard Westinghouse switchboard. A cooling-tower with fan draught is used for the condensing water. Cars are run with 2½ minutes headway at an average speed of 7 m.p.h. E. H. C.-H.

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365. *Swing-Bridge Crossing.* **E. Dieudonné.** (Écl. Électr. 16. pp. 353–360, 1898.)—Apropos of the Alexandria Tramways, detailed drawings are given of the contact devices where the line crosses a swing bridge. E. H. C.-H.

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366. *New Haven and Hartford Electric Railways.* **H. N. Heft.** (Street Rly. Journ. 14. pp. 540–542, 1898.)—Some description is given of the new trucks made by the Baldwin Locomotive Works for these lines. A few more details are also given of the construction and working of the lines (see 1898, Abstracts Nos. 218 and 716). W. R. C.

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367. *Electric Traction.* **A. H. Armstrong.** (Amer. Instit. Elect. Engin. 15. pp. 399–414, 1898.)—A paper dealing with the advantages of rapid acceleration, on the lines given by Steinmetz (see 1898, Abstract No. 346). The effect is also considered of constructing the permanent way with gradients leading up to and from the stations, and the most suitable length of gradient to employ when the stations are at short distances apart. W. R. C.

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368. *Cost of Electrical Energy for Tramways.* **R. W. Conant.** (Eng. News, 40. pp. 181–183, 1898.)—This is an analysis of the results obtained at forty-four power stations during the past year.

The author adopts the kilowatt-hour in preference to the car-mile as a standard of reference, and compares the working of the various stations with that of a standard station operating under the most favourable conditions. The equipment of the standard station is assumed to consist of three 1,200-kw. steam dynamos and six 500-H.P. water-tube boilers, with the usual accessories, the estimated costs being approximately as follows:—

	£
Buildings, foundations for machinery, chimney, coal handling apparatus, &c.	25,000
Engines and condensers, heaters, separators and piping	19,135
Feed pumps and economisers	3,750
Boilers and flues	12,700
Generators and switchboard	15,375
Land and docking facilities	3,540
Engineering and sundries	1,040
Total	£80,540
Cost per kilowatt capacity	£22·4

On the basis of an annual output of 10,500,000 kw.-hours, with a load factor of 33·3 per cent., the working expenses are:—

	d.
Interest, depreciation and taxes	0·20
Labour	0·08
Fuel at 14/- per ton	0·16
General expenses	0·05
Total per kw.-hour	0·49

Simple rules and diagrams are given for finding the costs of labour and fuel under various conditions of price of coal and labour, load factor, efficiency, &c. Other diagrams and tables show the actual cost of the respective items at several selected stations at different seasons, compared with the values estimated for the standard station. Usually the fixed charges, cost of fuel, cost of labour, and general expenses, are roughly in the ratio 4 : 4 : 2 : 1. The items of expense in some of the cases are discussed and explained. At three existing stations the working cost per kw.-hour is less than that given for the standard station.

A. H. A.

369. "*Anderson*" *Closed-Conduit System.* (Electrician, 42. pp. 38–39, 1898.)—The collector bar on the car makes contact with a pin which, when the car comes over it, rises 4 inches above road level while at the same time it becomes "alive." The short length of line now being tried at Leeds has not yet demon-

strated whether frost or wear and tear can interfere with the falling back of the contact pin into the safety position. The inventor states the cost of the surface contact boxes for the half-mile of experimental line at £600, but expects large reduction in price for quantities. E. H. C.-H.

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370. *Siemens and Halske Conduit Systems.* **G. Braun.** (Elect. World, 32. pp. 392–395, 1898. Abstracted from Elektrotechnische Zeitschrift.)—In the Budapest system there is an egg-shaped concrete conduit under one rail, containing two angle-iron conducting rails, one at each side of the conduit, fastened to the yokes by means of insulators. The yokes, placed at a distance, of 1·2 metres, support and maintain at the proper distance from each other the two halves of the tram rail which serves also as a slot rail, *i.e.*, the slot is not midway between the rails but coincides with the groove of one of them. The wheel flange is in the middle of the tyre. The pick-up device is two cast-iron shoes attached to a plough and pressing laterally outwards into the angle of the conducting rails. The conduits drain to sumps and are cleared out by egg-shaped shifters attached to a plough. As compared with American conduit practice the Budapest system has the advantage that less iron is required on the surface of the street. Points are a difficulty owing to necessity for retaining the full sectional profile of both the conduits. Diagrams show the devices adopted. To facilitate rapid change from conduit to trolley the plough is automatically ejected at the required point by an inclination in the floor of the conduit. In 1896, four million car kilometers were run in Budapest on this system. In Germany a similar system with ground return is being used. The conduits are completely interrupted at points and crossings, the ploughs being automatically ejected and then reinserted. E. H. C.-H.

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371. *Maxham Third Rail System.* **L. M. Maxham.** (Elect. Engin. N.Y., 26. pp. 439–440, 1898.)—Hollow sectional third rails are laid in the centre of the track and contain the insulated live line. Alongside the hollow rails runs a guard-rail so placed as to form a slot. Normally an insulating tongue fills this slot flush with the road; the car carries a cam which depresses the insulated tongue, thereby mechanically bringing the conductor into contact with the section of hollow rails over which the car is passing. Safety is claimed for the system, but no precaution seems to be taken to prevent the section being made alive by accidental pressure upon the insulated tongue. E. H. C.-H.

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372. *Surface Contact Systems.* (Zeitschr. Elektrotechn. Wien, 16. pp. 443–446, 1898.)—The various surface-contact systems

form the subject of this article. Descriptions are given of two systems of F. C. Esmond, and also of the system patented by the Union Elektricitaets-Gesellschaft, Berlin. E. H. C.-H.

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373. *Tramway Track Construction in Sioux City.* **C. P. Wilson.** (Street Rly. Journ. 14. pp. 439-442, 1898.)—The track consists of 60-lb. T rail on steel sleepers. After the rails were placed in position a longitudinal concrete beam, 15″ wide by 9″ deep, was formed under them as a foundation the whole length of the track. Extracts are given from the specifications. W. R. C.

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374. *Bow Form of Trolley.* **Stobrawa.** (Électricien, 16. pp. 97-100, 1898.)—To reduce the weight of the bow it is now frequently made of aluminium with white-metal rubbing surfaces. The old square form has given place to the triangular form which makes it impossible for the wire to lodge underneath the bow, when it is liable to wreck the overhead system. In Dresden the life of a bow covered with white-metal is about two weeks, while if made of aluminium it lasts eight weeks, corresponding to about eight car-kilometres. The cost of maintenance works out at Basle and at Dresden at 0·0875 centime per car-kilometre. Use of an annular contact surface facilitates the use of a lubricant which has the double advantage of making the sliding noiseless and rendering easy the removal of ice in winter. In Dresden the tension on the springs is specified not to exceed 3·5 kilogrammes. At curves an extra wire is used to prevent the bow striking cross wires. After four years' use it was found that the section of trolley wire was reduced to 96 per cent. of the original, owing to friction of the bow, but in this particular the bow is superior to the trolley as the latter also wears the side of the wire at curves. In the case of a bow the extra wear at curves falls on the additional guiding wire which is easily replaced. E. H. C.-H.

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375. *Rail Bonds.* (Street Rly. Journ. 14. pp. 519-523, 1898.)—An account of the more recent methods of bonding. W. R. C.

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376. *Line Poles.* (Street Rly. Rev. 8. pp. 241-244, 1898.)—Data are given with regard to comparative merit of poles of different kinds and settings for carrying electric lines. A sound wooden pole, with precautions taken for preservation, should last from eight to ten years, but this life may be greatly lengthened or shortened according to the various circumstances. The cost

of iron poles is prohibitive, except in the larger American cities, and the kind of wood selected depends on the locality. Pine is one of the most perfect and symmetrical of all timbers, and has a good tensile strength. In some cities, however, wooden poles are not permitted, and many street-railways use iron poles on account of their superior strength, longer life, and better appearance. The North and West Chicago Street Railways have a cast-iron sleeve, 2 in. thick, which is slipped over the pole and extends some distance above and beneath the surface of the street. This has proved very effective in preventing the poles from rusting at this point. The author emphasises the importance of painting the poles with the right paint, and gives details as to the best preparations to use for this purpose. Illustrations are given of the span wire arrangements for single and double tracks, and also of the arrangement of poles in use at Dover, Berlin, and Leeds. L. J. S.

377. *Inspection of Car Equipments.* **F. B. Perkins.** (Elect. Engin. 22. pp. 461–463, 1898.)—The author advocates daily rather than monthly inspection of cars. For a 50-car house with handling facilities five inspectors are recommended, two to attend to the motors, one to the controllers, one to the trolleys, and one to the trucks and car-bodies. Brushes should be treated with oil every few days, thereby materially increasing their life and minimising sparking. Every controller should be inspected and its contacts vaselined every fourth day. Inspection on the road is not recommended. All supplies should be tested before use. E. H. C.-H.

378. *Car Trucks.* (Eng. News. 40. pp. 164–166, 1898.)—This article describes a number of different types of trucks, dividing them into two classes: (1) trucks having springs over the axle boxes, (2) trucks having springs under the ends of the bolsters. The first class includes Ajax, Black Diamond, Cloud, Fox, Joughins, Kindl and Schoen trucks, while the second comprises the American, Haskell and Barker, N. Pacific Railway, Player, and Schoen trucks. E. H. C.-H.

379. *Single and Double Truck Cars.* **R. McCulloch.** (Elect. Engin. N.Y., 26. pp. 251–254, 1898.)—Twenty-two feet is about the limiting length of body of a single truck car: beyond this length double trucks must be used to avoid oscillation and grinding on curves. The expenses of the average city road may be divided up as follows: Maintenance of way and structures, 4 per cent.; maintenance of equipment, 7 per cent.; conducting transportation, 52 per cent.; general expenses, 8 per cent.; fixed charges, 29 per cent. If we reduce the number of cars by in-

creasing them in size we shall reduce the heaviest item (viz., conducting transportation) almost in proportion. Detailed tables are given comparing single and double trucks on the following points: (1) Cost of wheels and brake shoes per annum. (2) Repairs of trucks and motors. (3) Power required. (4) Weights carried empty and full. Taking into account the number of passengers carried, it appears that the costs under these various headings are about equal for single and double trucks. The trouble with maximum traction trucks getting off the line was due to the small weight put upon the trailers. Thirty per cent. of the weight is now put on the small wheels. In the discussion on this paper **J. I. Beggs** mentioned that at Milwaukee ten interurban cars were in use equipped with 4 "G.E. 1,000" motors geared to 26 miles per hour, weighted with 40,000 lbs., the cars weighing about 35,000 lbs. E. H. C.-H.

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380. *Peckham Maximum Traction Truck.* (Street Rly. Journ. 14. pp. 555–556, 1898.)—A new truck, No. 14 D 2 of the Peckham Truck Company, is illustrated and described. The special features are that it is centre-bearing and is fitted with a swing bolster; thus the truck wheels and car body are relieved from side thrusts on curves at high speed, and the trailing wheels are prevented from jumping the track. E. H. C.-H.

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381. *Cab Charging Station.* (Elect. World, 32. pp. 227–232, 1898.)—This article describes a new station of the New York Electric Vehicle Company, capable of accommodating 200 car-batteries simultaneously. The cabs are driven by motors geared to the forward wheels, and supplied with current from the battery box situated under the driver's seat. The 36-in. wheels consist of two solid steel discs 1/16 in. thick, carrying, on wooden rims, 5 in. single-tube pneumatic tyres, whose rubber walls are ¾ in. thick. The batteries contain 48 chloride cells of the F. V. type, mounted on one tray, the whole equipment weighing 1,300 lbs. The plates are separated by perforated, corrugated, hard rubber sheets. Speed variation is obtained by placing divisions of the battery in series or parallel, and, for the highest speed, by connecting the series field coils of the motors in parallel instead of in series. The motors are rated at 2 H.P. at 700 R.P.M., equivalent to a speed of 12 M.P.H. Elaborate arrangements are made to enable one man to remove the batteries from the vehicle, place them in position on a charging table, and return them to the vehicle when charged. In dismounting the cells, the weight of the cab is taken off the springs by hydraulic cylinders, and the battery is then withdrawn hydraulically and pushed on to a conveyor table, whence it is carried to a charging table by a special travelling crane.

Current is supplied to the batteries from one of four sets of bus bars, with pressures differing from each other by about five volts. By an arrangement of red and green signal lamps, the attendant is warned when to connect the cells on to the highest pressure. E. H. C.-H.

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382. *Motor-car Trials in France.* **E. Hospitalier.** (Ind. Élect. 7. pp. 272–286, 1898.)—This article illustrates and describes in detail the various motor-cars which took part in the trials carried out by the Automobile Club of France, June 1–11, 1898. All the cars used "Fulmen" accumulators and, with two exceptions, "Michelin" tyres. Five pages are occupied with tables showing the principal dimensions, characteristics, weights, loads, mechanical arrangements, &c., of the vehicles, together with the results of the trials, which included tests of the brakes and of power-consumption on different classes of road. In conclusion, the author remarks that he will be satisfied if next year's trials prove that the electric cab is practicable, and predicts that in two years' time it will have been shown to be economical. E. H. C.-H.

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383. *Motor-cars.* **E. Hospitalier.** (Ind. Élect. 7. pp. 287–299, 1898.)—The author gives some account of the exhibition organised by the Automobile Club of France in the Tuileries. Two hundred and fifty motor-cars were shown. Thirty of these were electrical, and are illustrated and described in detail under four headings:—(1) Cabs and other vehicles plying for hire. (2) Private conveyances manœuvred by a coachman. (3) Private conveyances manœuvred by the owner. (4) Delivery vans. E. H. C.-H.

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384. *Electric Motor-cars.* **J. Reyval.** (Écl. Électr. 16. pp. 453–456, 1898.)—The Bouquet, Garcin et Shivre (B.G.S.) system is peculiar in a few points. Special accumulators are used weighing only 350 kg. on a vehicle weighing 1,000 kg. (gross) which is capable of running 100 to 150 km. with one charge. The armature of the motors is wound in two unequal sections, the number of turns being in the ratio of 5 to 3. By this means seven speeds can be obtained without altering the arrangement of the cells or varying the motor-fields. E. H. C.-H.

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385. *Electric Motor-cars.* (Elect. World, 32. pp. 483–488, 1898.)—Three illustrated articles describe electric vehicles made by the Pope Manufacturing Co., the Riker Electric Motor Co., and the General Electric Automobile Club. E. H. C.-H.

386. *Cost of Electrical Energy.* **M. E. Turner.** (Elect. World, 32. pp. 209–210, 1898.)—This paper is intended to illustrate the Wright system of charging for electrical energy, and consists chiefly of a discussion of the correct apportionment of each item of expenditure between fixed and running expenses. On certain assumptions, the following conclusions are based :—

	Fixed Expenses.	Running Expenses.	Total per kw. hr.
Cost of 1 kw. for 1 hour per day	14d.	0·5d.	14·5d.
,, ,, 2 hours ,, ...	14d.	1·0d.	7·5d.

A. H. A.

387. *Charging for Electrical Energy.* **A. Meynier.** (Ind. Elect. 7. pp. 377–378, 1898.)—The rational charge for electrical energy depends upon the following conditions :—

1. Local conditions.
2. The duration of the utilisation of the energy.
3. The time at which the energy is used; day or night, summer or winter.
4. The importance of the consumer.

It ought not to depend upon the use to which the energy is applied.

In order to be favourable to good clients, the author suggests that a reduction y in the charge should be given, where

$$y = a - \frac{b}{x+k}$$

x being the number of 16 C.P. lamps installed, and a, b, and k certain constants dependent upon the other conditions. An additional reduction should be made proportional to the ratio of the watts used to the number of lamps installed. W. G. R.

388. *Incandescent Lamps.* **S. E. Doane.** (Elect. World, 31. pp. 785–787, 1898.)—Change of resistance has little to do with alteration in candle power of a lamp, and any change in C.P. without a change in watt-consumption is due to alteration in the surface of the filament. Almost all lamps rise rapidly in C.P. during the first two or three hours of use, but afterwards the curve of C.P. falls almost in a straight line. Blackening of the lamp bulb, which is largely a chemical effect, is responsible for very little of the drop in C.P., most of it being accounted for by the increase in area of the filament surface. E. H. C.-H.

389. *Cotsworth Arc Lamp.* (Elect. Engin. 21. p. 779, 1898; British Patents Nos. 23462 of 1895 and 17832 of 1896.)—This is a clutch lamp in which the brake-block is mounted on a spring which is attached to the end of a swinging lever acted upon by the regulating electromagnet. The lamp is a focussing one, a coil passing over the brake-wheel and connecting the rods carrying the carbons; these rods are square and rest in a right-angled V-groove in the periphery of the brake-wheel. Another feature of the lamp is the globe-lowering gear. This comprises two rods which support the globe and are arranged on opposite sides of the lamp and have valved pistons at their ends working in tubes in the cover. These valved pistons allow the globe to be raised rapidly, but on descending the valves close and prevent the globe from falling too quickly. Catches are provided for locking the rods in their uppermost position. C. K. F.

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390. *Electric Train Lighting.* (Railroad Gazette, 30. pp. 668–669, 1898.)—The Stone system of lighting railway trains, by means of accumulators and a dynamo driven from the axle of the guard's van is described. The dynamo is so suspended that the tension of the belt cannot exceed a certain prearranged limit, beyond which the belt slips on the pulley, while the armature is driven at a constant speed. A mechanical governor switches the accumulators off when the train slackens speed. Experiments show that the dynamo speed is constant while the speed of the train varies from 24 to 72 miles per hour. The power absorbed is from 0·6 to 1·1 H.P. for an ordinary coach, consuming about 0·05 lb. coal per coach per mile. A. H. A.

TELEGRAPHY AND TELEPHONY.

391. *Telephone Central Equipment.* **H. P. Clausen.** (West. Electn. 23. pp. 2–3, 1898.)—The "multiple-plug" system depends on multiplying the calling instead of the called connections as in the multiple-jack. It is cheaper in first cost if there are two or three thousand subscribers. The Dalmarvia system is described in some detail. M. O'G.

392. *Telephone Indicator.* **P. Rabbridge.** (Elect. Rev. 43. p. 731, 1898.)—The one described consists of a permanent magnet on the keeper of which is wound a coil, which releases the keeper if influenced by a signal current. M. O'G.

393. *Luminous Signal Boards.* **K. B. Miller.** (Amer. Electn. 10. pp. 433–436, 1898.)—The direct and relay connections are shown. The lamps will stand a million signals and last twenty-five years. M. O'G.

394. *Automatic Telephone Board.* (Electrician, 41. pp. 522–523, 1898.)—Referring to Electrician, May 6th, p. 52, the author outlines the "bridging system" whereby any one of 10,000 subscribers may be selected and called. M. O'G.

395. *Telephone Call Dials on Series System.* **L. Montillot.** (Électricien, 16. pp. 119–122, 1898.)—When station A wishes to call station G which is on the same line and in series with stations B, C, D, without disturbing them, A starts an electrically wound clock in all the stations, and at the moment his own pointer passes the G engraved on his dial he depresses a key and secures G's attention. Full details are given. M. O'G.

396. *Combined Telephone and Electric Light Stations.* **H. P. Clausen.** (West. Electn. 22. pp. 332–333, 1898.)—The same linesmen, trenchwork, and centres are available. Protective devices are explained. M. O'G.